TOPCON

# REPAIR MANUAL

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REVISED·····

**AUTOMATIC LEVEL**

# AT-B2/B3/B4

**TOPCON CORPORATION**

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# 1. INTRODUCTION

This service manual describes the replacement, inspection and adjustment procedures for the AT-B2, AT-B3 and AT-B4 automatic levels.

## Features

- The AT-B2/B3/B4 is equipped with a fast-action, magnetically-damped, automatic compensator. After the instrument has been approximately levelled using the circular level, the line of sight is accurately levelled by the automatic compensating mechanism.
- The AT-B2/B3/B4 has been designed to allow stable surveying operations regardless of environmental conditions such as vibration and temperature changes.
- The AT-B2/B3/B4 has a simple horizontal circle for angle measurement, and the stadia lines on the reticle can be used for approximate distance measurement.
- The AT-B2/B3/B4 is ideally suited for general survey work, civil engineering and construction work.
- The shortest focus is 0.3m. This product is particularly useful for measurement works at narrow places.

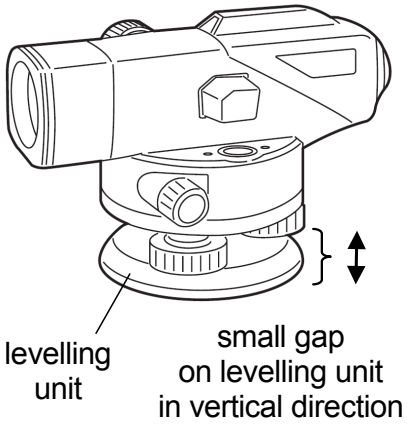
Note: The instrument is accurately levelled when the bubble is within the center circle of the circular level, unless the precise inspection and adjustment requiring the test level (as specified in chapter 5 of this service manual) is performed by the service center.

The following basic differences in specifications feature all models:

| | AT-B2 | AT-B3 | AT-B4 |
|---|---|---|---|
| Objective aperture | 42mm (1.65 in.) | 36mm (1.42 in.) | 32mm (1.26 in.) |
| Magnification | 32x | 28x | 24x |
| Field of view (at 100m/328ft.) | 1°20' (2.3m/7.5ft.) | 1°25' (2.5m/8.2ft.) | |
| Resolving power | 3.0" | 3.5" | 4.0" |
| Standard deviation for 1 km of double run leveling | 0.7mm (0.03in.) | 1.5mm (0.06in.) | 2.0mm (0.08in.) |
| With micrometer | 0.5mm (0.02in.) | -------- | |

Note about the gap between the levelling unit and the vertical axis nut resulting in slight movement of the levelling unit against the telescope frame of the instrument in the vertical direction:

If you hold the base plate in one hand and apply a force with other hand to move the telescope upward against the levelling unit, you may notice some gap in the vertical direction. This is normal – the clearance originates from the mechanical structure of the instrument and does not affect the instrument accuracy.




**Symbols:**

The following conventions are used in this manual:

- ✍ Indicates supplementary explanation
- ☞ Indicates the chapter (section) title to refer to for additional information

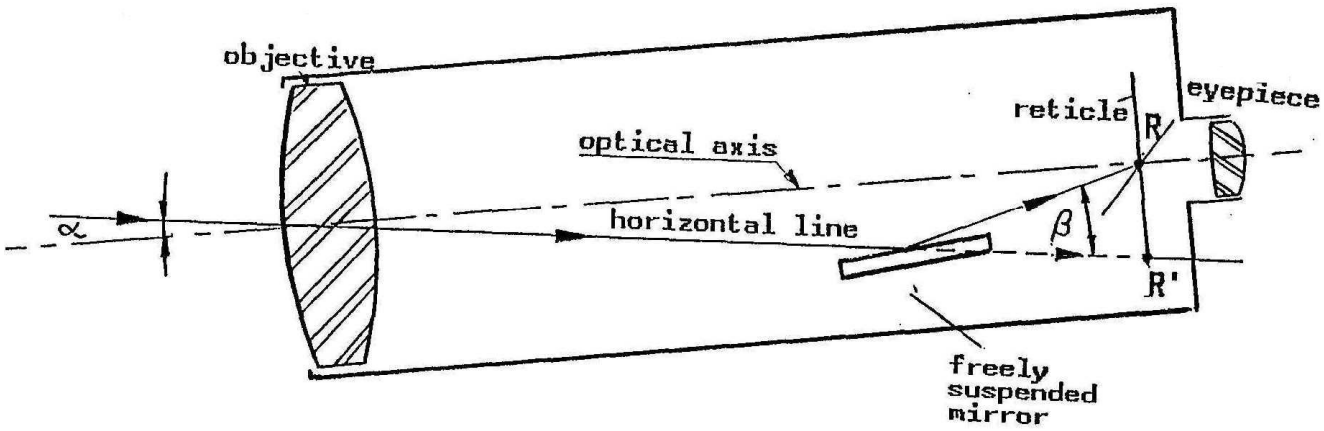
# 2. OPTICAL COMPONENTS LAYOUT

## 2.1 PRINCIPLE OF AUTOMATIC LEVEL

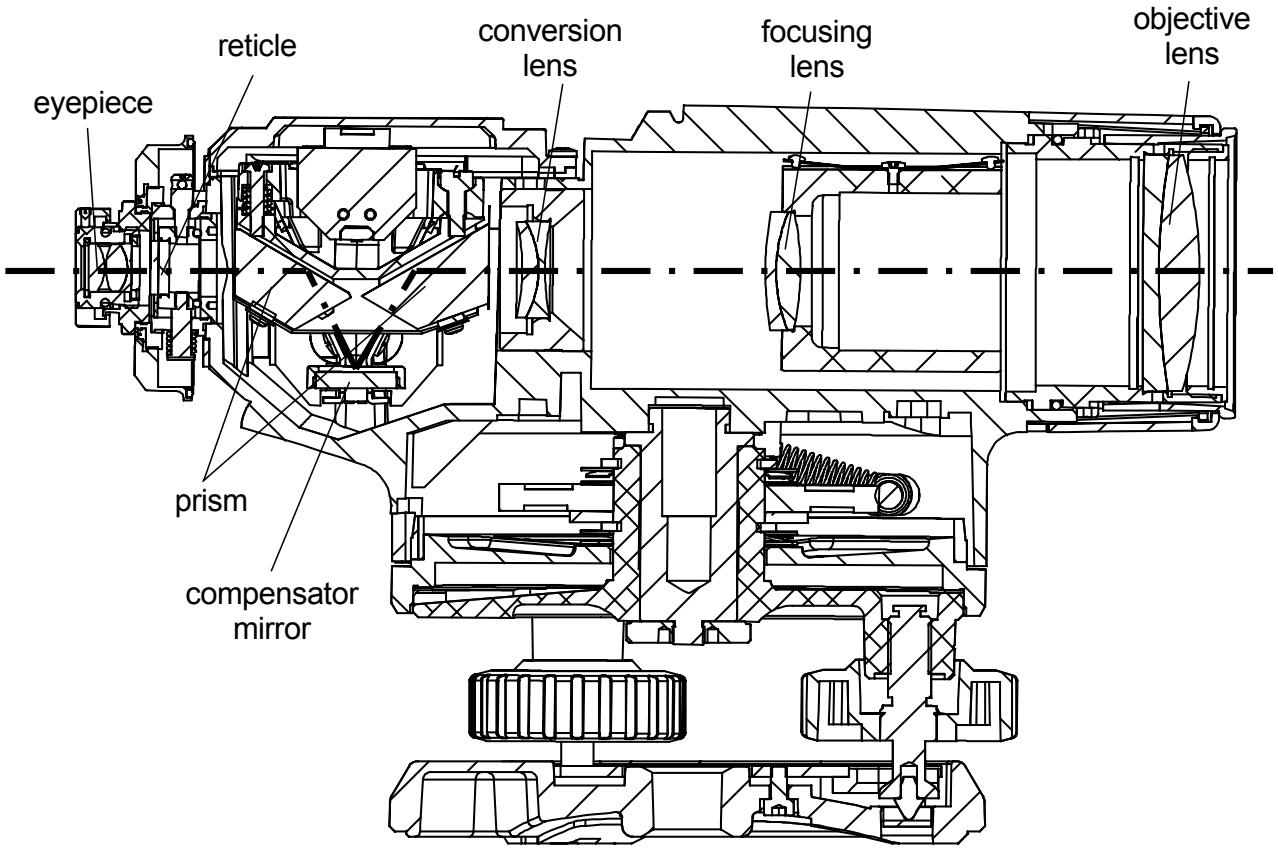
An automatic level is designed to keep the line of sight horizontal (within the compensation range) by means of a system of prism and a mirror supported by wires as in pendulum.
When the telescope barrel is horizontal, rays of light emanating from an objective lens are focused on the reticle center (R). However, without a compensator, the focused point moves to the point (R') when the instrument is tilted at an angle of α.

The mirror of the compensator, being freely supported, is inclined by gravity and changes the rays of light at an angle of β in proportion to α so as to maintain a horizontal line of sight.

The clamped magnet at the top of the compensator, making a practical application of the magnetic damping, stops a swing of the pendulum to stabilize the line of sight.



# 2.2 DIAGRAM OF OPTICAL LIGHT PATH



# 3. DISASSEMBLING AND ASSEMBLING

This chapter describes the disassembling and assembling of each unit. Follow the procedures in the consecutive order. Also use the specified cleaning detergent and grease when needed.

Cleaning detergents:

| | |
|---|---|
| Metal parts | (white) gasoline |
| Plastic parts | neutral detergent |
| Glass parts | ethyl alcohol (30%) and ether (70%) |

Greases and adhesives: Specified in the procedure and in chapter 6 “Exploded view”. Gxx denotes the part code for the grease applied to the particular parts of the instruments, Sxx (or Sxxx) denotes the part code for the adhesives.

## 3.1 BASE UNIT

**<Disassembling>**

**(1)** Unscrew the 3 levelling screws [14] from the levelling head [15] to separate the base plate unit from the upper part of the instrument.

**(2)** Unscrew the vertical axis nut [2] by using the spanner and remove the levelling head unit [15] from the vertical axis [1].

**(3)** Remove the C ring [3] using the snap ring pliers. Remove the plate A [4], wave washer [5], plate A [6], worm wheel [7] and washer B [8] from the levelling head [15].

**(4)** Remove the C ring [9] using the snap ring pliers. Remove the plate A [10], worm wheel plate spring [11], horizontal circle [12] and horizontal circle ring [13] from the levelling head [15].

**(5)** Unscrew the 3 screws [20] fixing the base plate [19] and levelling screw retainer [16].

**(6)** Remove the levelling screw retainer [16] from the base plate [19].

**(7)** Remove the levelling screws [14] with the levelling screw pads [17] from the base plate [19].

**(8)** Remove the levelling screw plates [18] from the base plate [19].

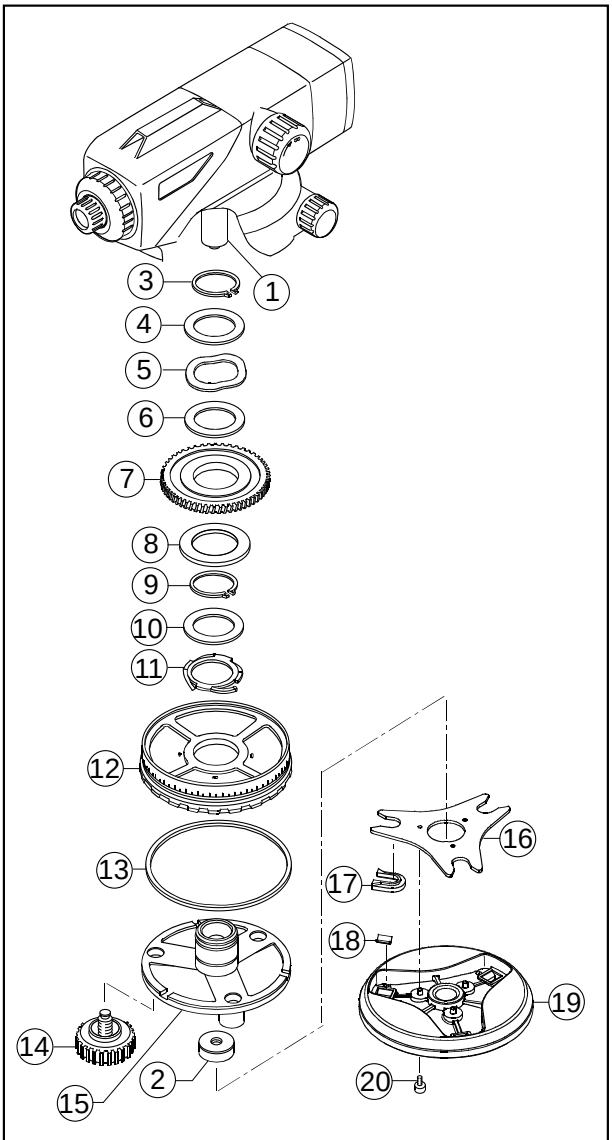



**Fig. 3-1**

**<Assembling>**

**(9)** Apply a small quantity of G32 to the surfaces for the levelling screw plates [18] on the base plate [19]. Place the levelling screw plates [18] on the base plate.

**(10)** Apply G38 to the levelling screw plates [18].

**(11)** Apply G38 to the levelling scew pads [17] (to the contact surfaces for the levelling screws).

**(12)** Apply G32 to the thread of the levelling screws [14].

**(13)** Install the levelling screw pads [17] and levelling screws [14] in the levelling screw retainer [16].

✍ Place the levelling screw retainer [16], so that the surface of better finish is upside (i.e. the levelling head side).

**(14)** Screw the levelling screws [15] into the levelling head [16] approximately to the same height.

**(15)** Place the base plate [19] with the levelling screw plates [18] on the tips of the levelling screws and temporary tighten the 3 screws [20] fixing the base plate [19] and levelling screw retainer [16] with torque of 1.2 kgf·cm (0.12 N·m).

**(16)** Apply a small quantity of G33 to the contact surfaces of the levelling head [15] and horizontal circle [12]. Excessive appliance of the grease results in the increase of the rotation torque.

**(17)** Place the horizontal circle ring [13] between the horizontal circle [12] and the levelling head [15]. Put together the horizontal circle [12] and levelling head [15].

**(18)** Slip the worm wheel spring [11] and plate A [10] to the levelling head [l5]. Fix the C ring [9] using the snap ring pliers.

✍ Install the plate A [10] and the C ring C [9] with the smooth edges (i.e. press punch side) facing down.

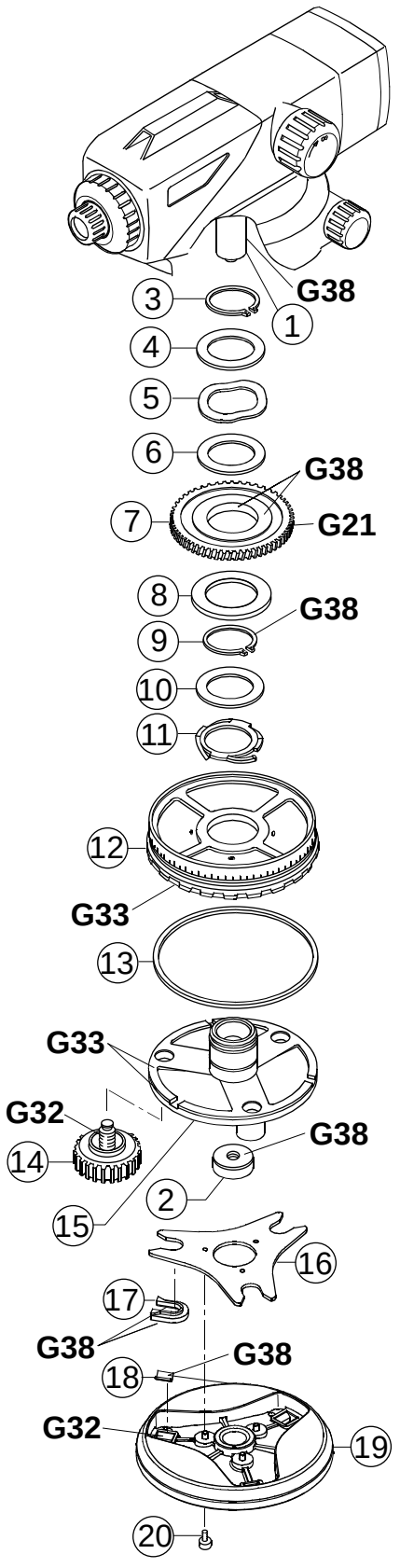



**Fig. 3-2**

**(19)** Apply G38 to the upper side of the C ring [9].

**(20)** Apply G21 to the cogs of the worm wheel [7]. Apply G38 to the worm wheel [7] to the surfaces, which are in contact with the washer A [6] and levelling head tube [15].

**(21)** Put the washer B [8], worm wheel [7], plate A [6], wave washer [5] and plate A [4]. Fix the C ring [3].

✍ Install the washer B [8] and C ring [3] with the smooth edges (i.e. press punch side) facing up and the plate A [6] with the smooth edges (i.e. press punch side) facing down. The plate A [4] can be placed in any direction.

**(22)** Apply G38 to the vertical axis.

**(23)** Apply G38 to the upper surface of the vertical axis nut [2] and tighten the nut to put together the base unit and telescope frame.

**(24)** Adjust the 3 screws [20] fixing the base plate [19] and levelling screw retainer [16] so that the 3 levelling screws can be smoothly rotated with the same torque.

**(25)** Apply the locking agent (S102) to the tips of the screws [20] at the upper side of the levelling screw retainer [16].

**(26)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

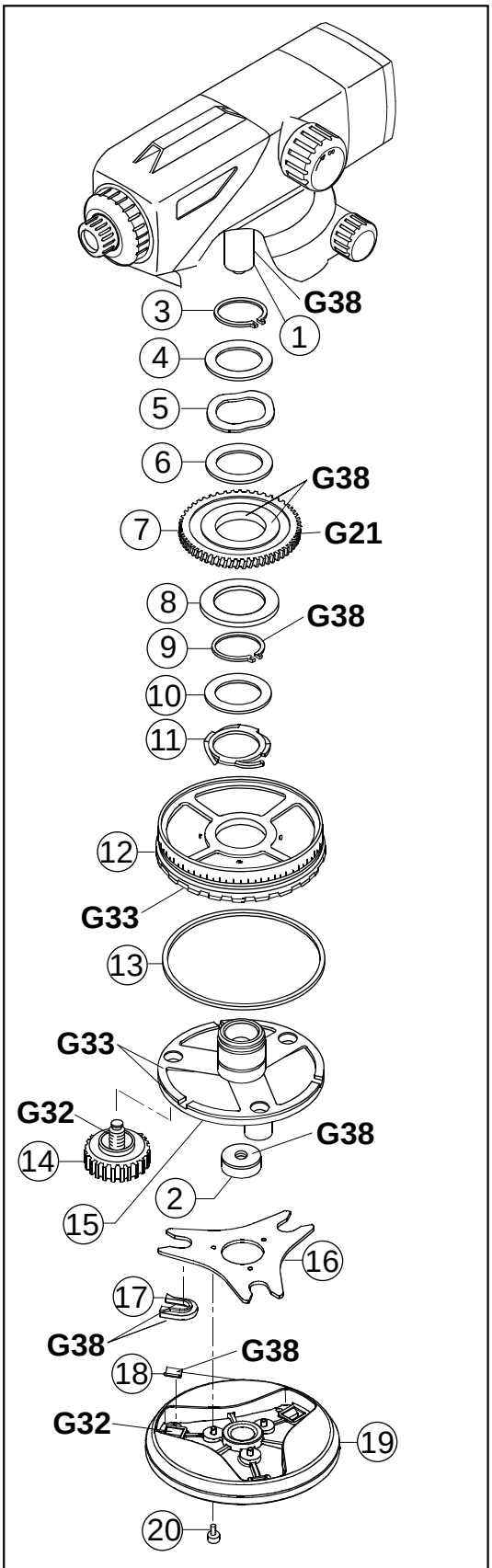



**Fig. 3-3**

# 3.2 FINE MOTION SCREW UNIT

**<Disassembling>**

**(1)** Unscrew the vertical axis nut and remove the base unit from the telescope frame (☞ section 3.1 page 3-1).

**(2)** Remove the fine motion knob cover [1] from the fine motion knob [3].

**(3)** Loosen the fine motion knob set screw [2] and unscrew the fine motion knob [3].

**(4)** Loosen the coil spring screw [6] and remove the coil spring hook from the screw. Undo the coil spring [6] from the channel of the fine motion shaft and pull out the worm complete [8] from the telescope frame.

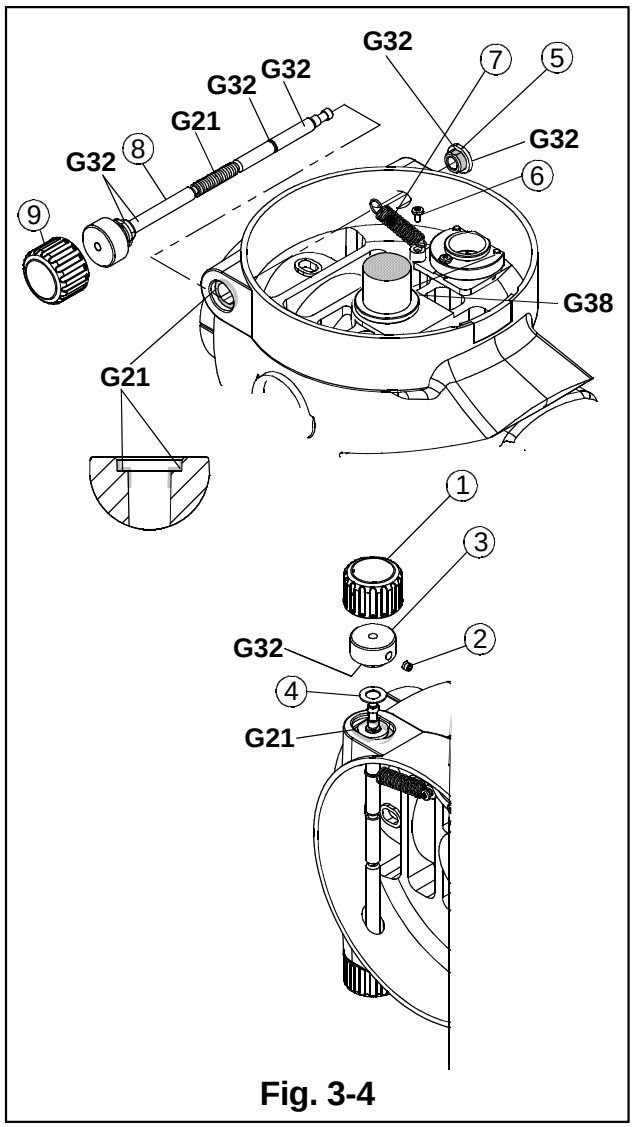



**Fig. 3-4**

**<Assembling>**

**(5)** Apply G21 to the cogs of the worm complete, apply G32 to the channel of the fine motion shaft and the ends of the fine motion shaft.

**(6)** Apply G32 to the worm metal B [5] and front surface (which is in contact with the spring washer [4]) of the fine motion knob [3].

**(7)** Insert the fine motion shaft to the telescope frame from the focusing knob side.

**(8)** Fit the hook of coil spring [6] in the channel of the fine motion shaft and attach the coil spring to the fixing screw [6]. Tighten the screw and apply the locking agent (S91) to the screw.

**(9)** Insert the worm metal B [5] (w/guide channel), spring washer [4] and screw the fine motion knob [3].

**(10)** Tighten the fine motion knob set screw [2]. Put the fine motion knob cover on the fine motion knob.

**(11)** Apply G38 to the vertical axis.

**(12)** Tighten the vertical axis nut to put together the telescope frame and base unit.

**(13)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

# 3.3 VERTICAL AXIS

**<Disassembling>**

**(1)** Unscrew the vertical axis nut and remove the base unit from the telescope frame (☞ section 3.1 page 3-1).

**(2)** Fix the vertical axis [1] on the vertical axis mounting tool [2] using a parallel bench vice [3]. Turn the telescope frame counterclockwise to remove the vertical axis.

Since the vertical axis is glued to the telescope frame, warm up the vertical axis when having difficulty in turning the telescope frame.

**Caution!**

Do not use the removed vertical axis.

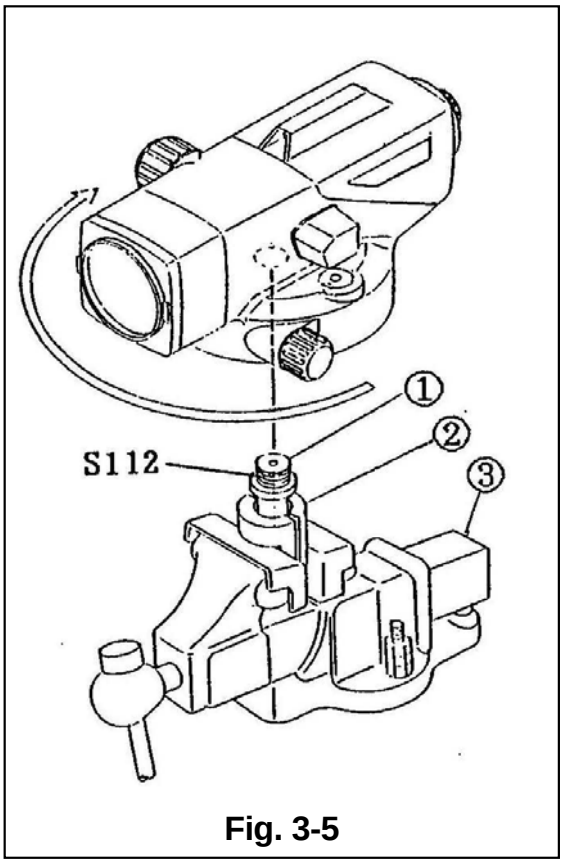



**Fig. 3-5**

**<Assembling >**

**(3)** Apply adhesive (S112) to the screw part of the vertical axis [1]. Screw the vertical axis [1] to the telescope frame using the vertical axis mounting tool [2].

**(4)** Apply G38 to the vertical axis [1].

**(5)** Tighten the vertical axis nut to put together the telescope frame and base unit.

**(6)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

# 3.4 INDICATOR

**<Disassembling>**

**(1)** Unscrew the vertical axis nut and remove the base unit from the telescope frame (☞ section 3.1 page 3-1).

**(2)** Remove the indicator [1] from the telescope frame [2] using the pliers.

**<Assembling >**

**(3)** Clean the contact surface for the indicator on the telescope frame.

**(4)** Apply adhesive (S111) to the surface.

**(5)** Stick the indicator on the telescope frame so that both surfaces are even.

**(6)** Apply adhesive (S113) at the left and right side of the indicator and contact surface of the telescope frame. Make sure that the glue does not come outside the groove area of the telescope frame (i.e. the surface "B" is clean).

**(7)** Apply G38 to the vertical axis.

**(8)** Tighten the vertical axis nut to put together the telescope frame and base unit.

**(9)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

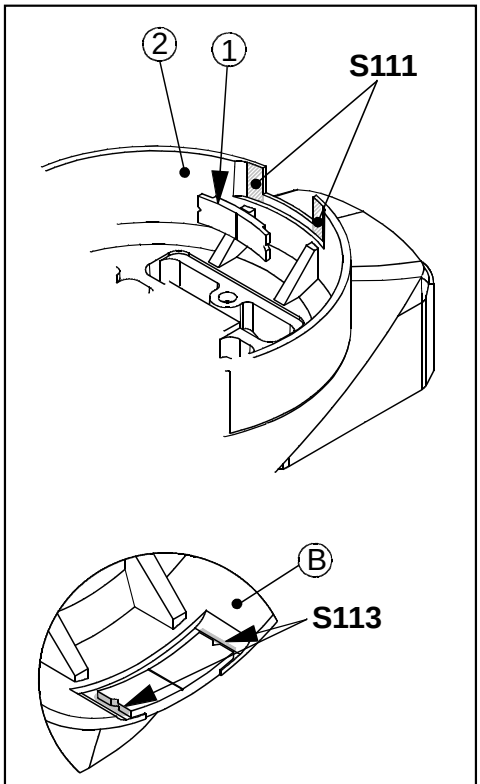



**Fig. 3-6**

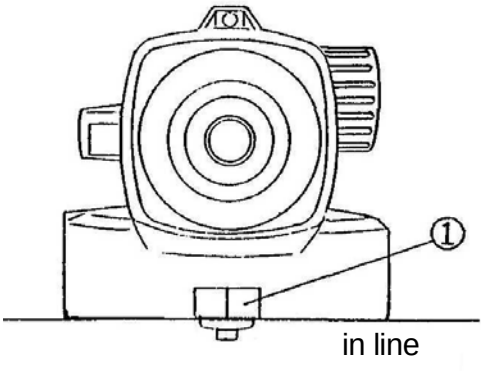



**Fig. 3-7**

# 3.5 CIRCULAR LEVEL

**<Disassembling>**

**(1)** Unscrew the vertical axis nut and remove the telescope frame from the base unit (☞ section 3.1 page 3-1).

**(2)** Unscrew the 2 circular level adjusting screws [1].

**(3)** Turn the telescope frame upside down and unscrew the circular level frame screw [5].

**(4)** Remove the circular level [4], O-ring [2] and circular level spring [3].

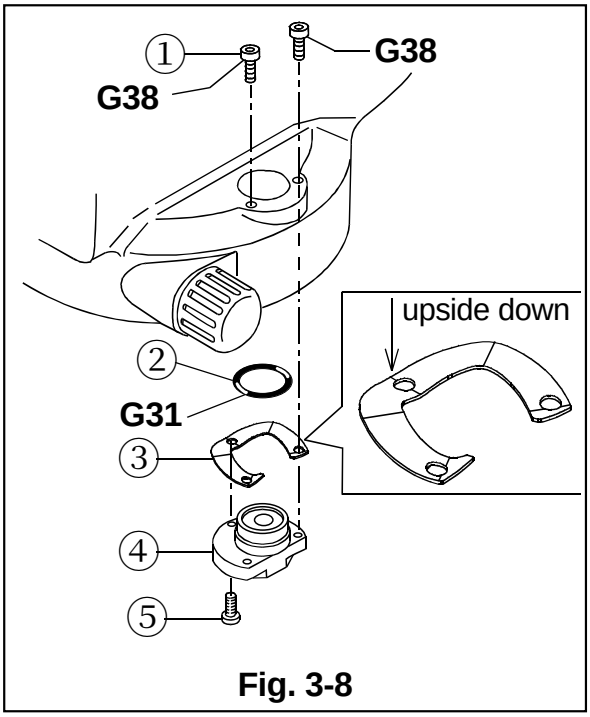


**Fig. 3-8**

**<Assembling >**

**(5)** Slip the O-ring [2] and the circular level spring [3] (take care of the upside down) to the circular level [4].

✍ The spring at the center hole location should touch the cricular level frame (not telescope frame) before the screw is tightened.

**(6)** Apply G31 to the O-ring [2].

**(7)** Fit the circular level.

**(8)** Slightly tighten the circular level frame screw [5].

**(9)** Apply a small quantity of G38 at the lower side of the 2 circular level adjusting screw heads [1] and slightly tighten the screws.

**(10)** Tighten the circular level frame screw [5] with torque of 4.5 kgf·cm (0.45 N·m).

**(11)** Apply G38 to the vertical axis.

**(12)** Tighten the vertical axis nut to put together the telescope frame and base unit.

**(13)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

# 3.6 REFLECTOR

**<Disassembling>**

**(1)** Pressing the reflector cover [1] from both sides, remove the reflector cover [1].

**(2)** Unscrew the 2 reflector frame screws [2] to remove the reflector frame [3].

**(3)** Remove the tape [6] from the reflector frame.

(AT-B2)

**(4)** Remove the penta-prism [4] from the reflector frame [3].

(AT-B3/B4)

**(5)** Remove the reflector [5] from the reflector frame [3].

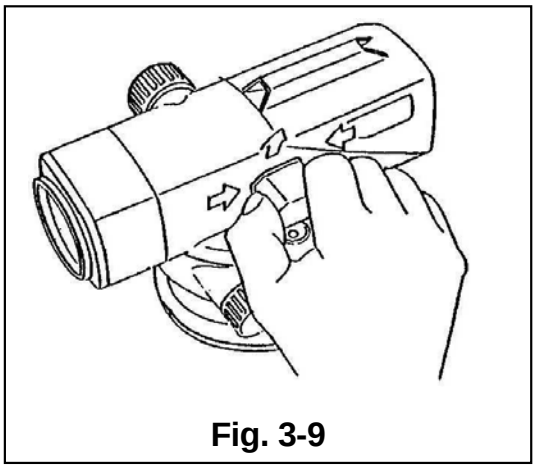


**Fig. 3-9**

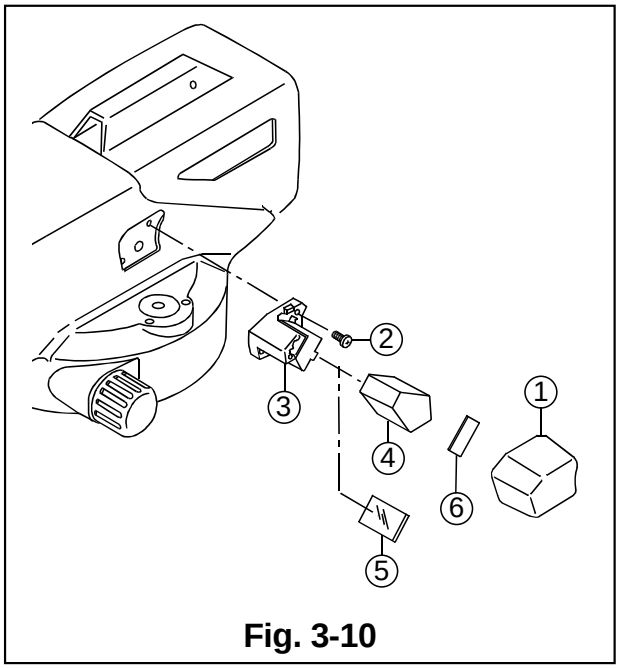



**Fig. 3-10**

**<Assembling >**

(AT-B2)

**(6)** When the new reflector frame [3] is used break the reflector holder "A" by using the pliers and fit the penta-prism to the reflector frame.

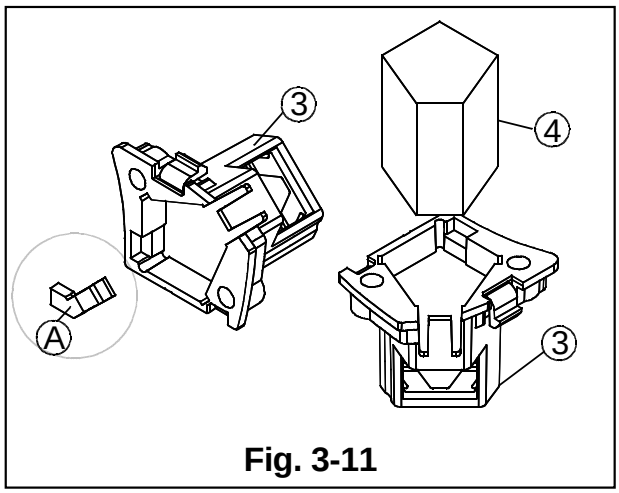



**Fig. 3-11**

(AT-B3/B4))

**(7)** Pull the reflector holder "A" slightly upward and slide the reflector [5] into the reflector frame [3].

✍ Keep the black painted surface and non-painted area "B" of the reflector [5] at the position as shown at right.

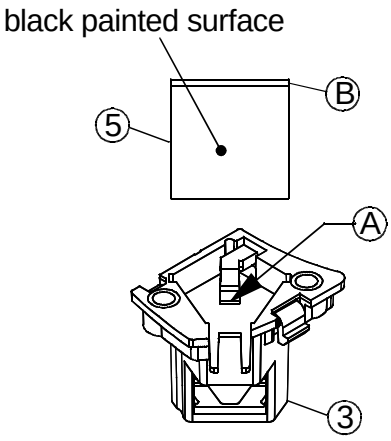



**Fig. 3-12**

(AT-B2/B3/B4)

**(8)** Put the double-sided adhesive tape [6] on the front side of the reflector frame [3].

**(9)** Attach the reflector frame [3] to the telescope frame using the 2 fixing screws. Tighten the screws with torque of of 1 kgf·cm (0.1 N·m) and apply the locking agent (S91) to the screws.

**(10)** Relocate the reflector cover [1].

✍ When any parts of the reflector complete are removed and assembled, replace the double-sided adhesive tape [6] for a new one.

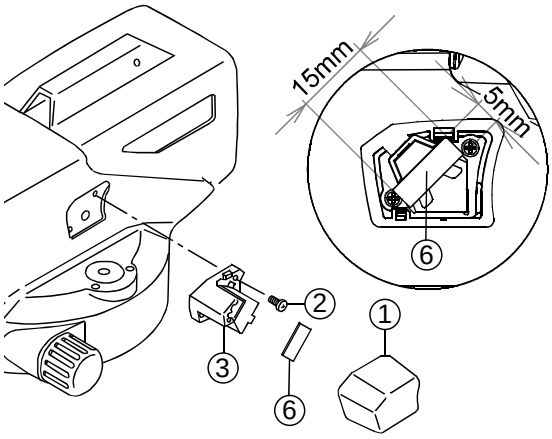



**Fig. 3-13**

# 3.7 OBJECTIVE LENS

The objective lens complete for each model AT-B2/B3/B4 is different.

**<Disassembling>**

**(1)** Remove the objective lens frame cover [2] from the telescope frame. (Press the part "A" to unfold the part "B").

✍ In the AT-B2 remove the objective lens frame cover [2] with sunshade [1] (sunshade is used only in AT-B2).

**(2)** Unscrew the 2 objective lens outer frame screws [3]. Remove the objective lens outer frame [4].

**(3)** Unscrew the stadia adjusting nut [5] using the stadia nut mounting tool [9]. (AT-B2 only)

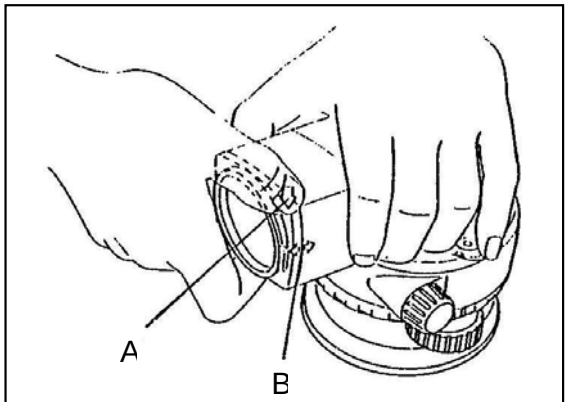



**Fig. 3-14**

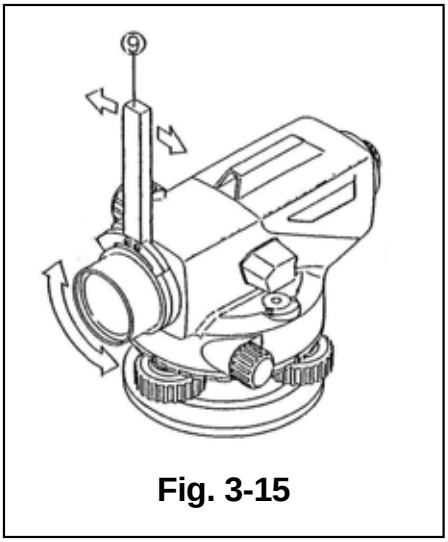



**Fig. 3-15**

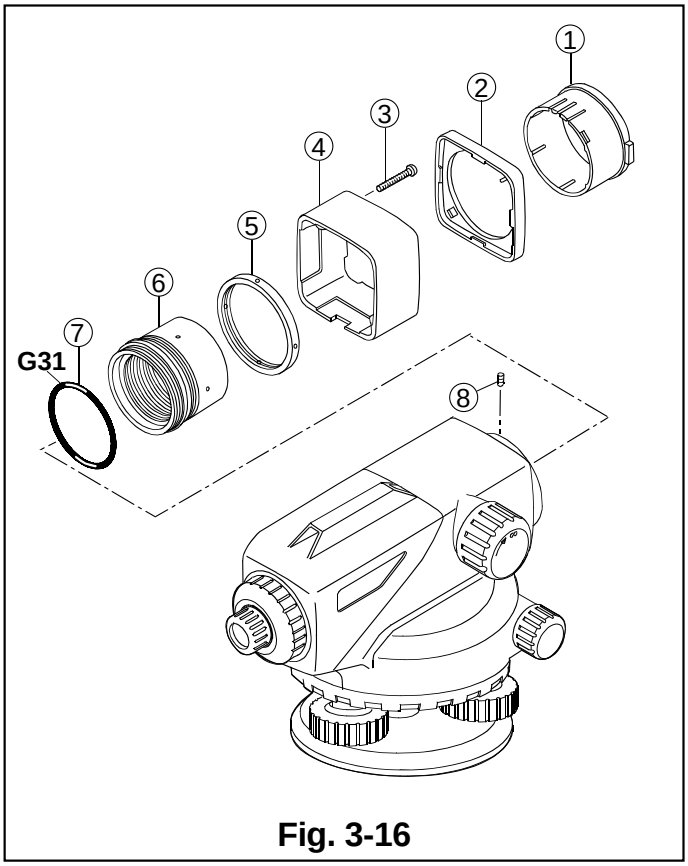



**Fig. 3-16**

**(4)** Loosen the objective lens set screw [8] (hexagonal socket screw). (AT-B3/B4 only)

**(5)** Unscrew the objective lens [6] (with O-ring [7]) from the telescope frame.

**<Assembling >**

**(6)** Apply G3l to the O-ring [7] on the objective lens [6].

**(7)** Screw the objective lens [6] to the telescope frame.

✍ Install the objective lens [6] by rotating it approximately 2 and half revolutions. This is initial setting before the further stadia ratio adjustment.

**(8)** Proceed with the adjustment of stadia ratio (☞ section 5.2.11 page 5-12).

(AT-B2)

After adjustment apply the locking agent (S91) to the stadia adjusting nut [5] and silicone glue (S138) to the hole "C" in the telescope frame.

(AT-B3/B4)

After adjustment apply the locking agent (S91) to the objective lens set screw [8].

**(9)** Relocate the objective lens outer frame [4] using the two screws [3]. Tighten the screws with torque of 4.5kgf·cm (0.45N·m)

**(10)** (AT-B2)

Put the objective lens frame cover [2] and sunshade [1] onto the objective lens outer frame.

✍ Align (a), (b) and (c).

(AT-B3/B4)

Relocate the objective lens frame cover [2].

**(11)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

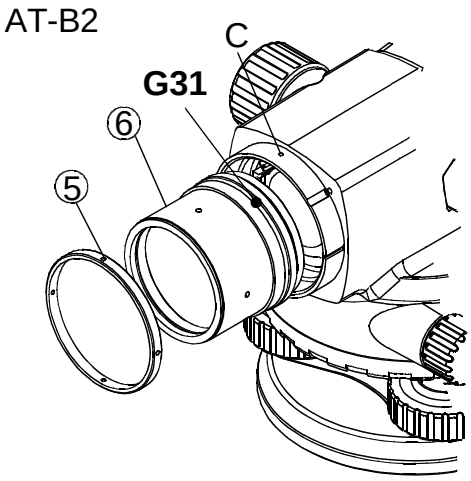



**Fig. 3-17**

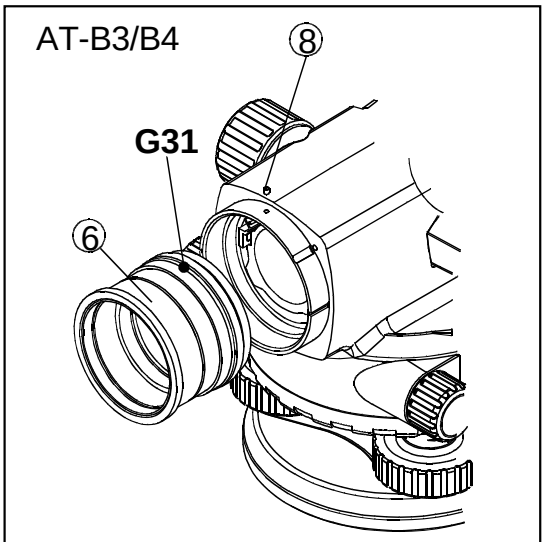



**Fig. 3-18**

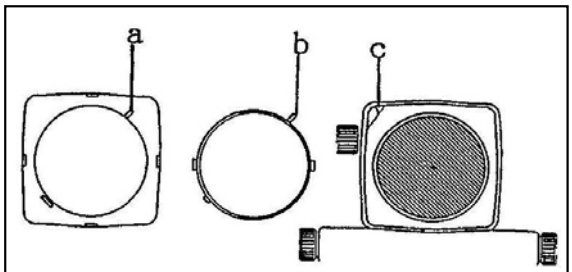



**Fig. 3-19**

# 3.8 FOCUSING TUBE AND PINION

The focusing tube and pinion complete of the AT-B2 is different from those of AT-B3/B4.

**<Disassembling>**

**(1)** Remove the objective lens from the telescope frame (☞ section 3.7 page 3-10).

**(2)** Remove the pinion knob cover [5].

**(3)** Loosen the 2 pinion set screws [4]. Pull out the pinion [6] from the telescope frame.

**(4)** Pull out the focusing tube from the [3] from the telescope frame.

**(5)** When replacing the rack [2] on the focusing tube, remove the 2 rack screws [1].

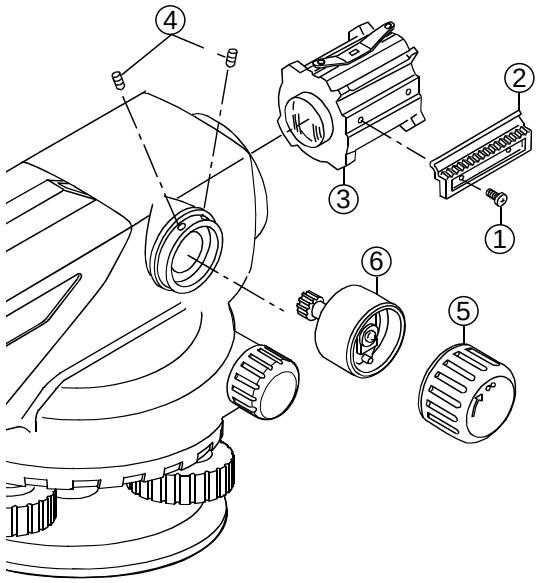



**Fig. 3-20**

**<Assembling >**

**(6)** When the rack [2] is removed, tighten the 2 rack screws pressing the rack [2] downward and backward (in the eyepiece direction). Apply the locking agent (S91) to the fixing screws.

**(7)** Apply G38 to the cogs and the upper surface of the rack [2].

**(8)** Apply G42 (AT-B2) or G30 (AT-B3/B4) to the surface inside the telescope tube for the focusing tube.

**(9)** Insert the focusing tube [3] to the telescope frame.

**(10)** Fit the cogs of the rack [2] and pinion [6].

**(11)** Turn the pinion [6] so that the focusing tube [3] moves all in the direction of the objective lens.

**(12)** Getting out of gear (turning the focusing tube counterclockwise), adjust the focusing tube [3] position so that the edge of the focusing tube [3] is level with the rim for the objective lens inside the telescope frame.

**(13)** Tighten the 2 pinion set screws.

**(14)** Put the pinion knob cover [5] on the pinion knob [6].

**(15)** Check if the focusing tube runs smoothly. Make sure that in the limit position the focusing tube is aligned with the rim for the objective lens inside the telescope frame or it is slightly below the rim (i.e. in the direction to the inside of the telescope tube).

**(16)** Install the objective lens complete (☞ section 3.7 page 3-11).

**(17)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

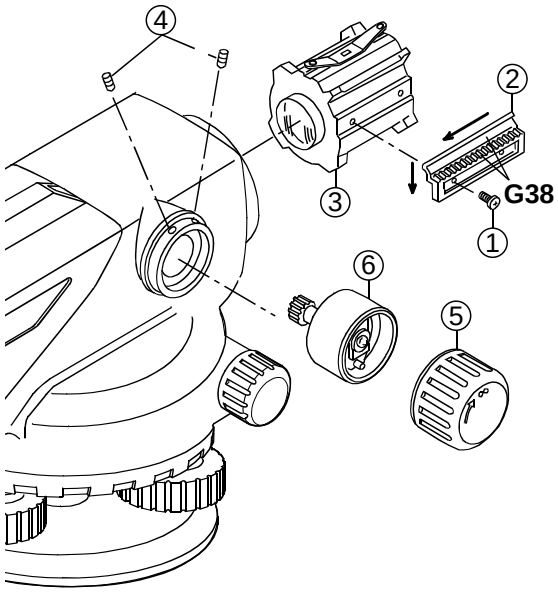
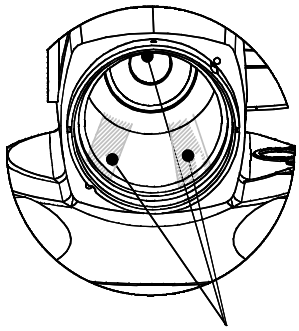
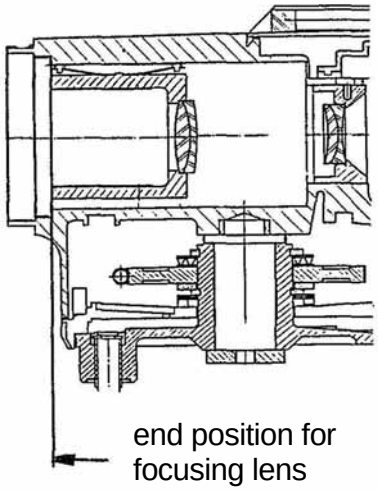



**Fig. 3-21**



G42 (AT-B2)
G30 (AT-B3/B4)
inside telescope frame

**Fig. 3-22**



end position for
focusing lens

**Fig. 3-23**

# 3.9 CONVERSION LENS

The conversion lens of the AT-B2 is different from those of AT-B3/B4.

**<Disassembling>**

**(1)** Remove the objective lens complete (☞ section 3.7 page 3-10).

**(2)** Remove the focusing tube and pinion (☞ section 3.8 page 3-12).

**(3)** Remove the compensator (☞ section 3.12 page 3-21).

**(4)** Unscrew the 2 conversion lens tube screws [3]. Pull out the conversion lens [1] or [2] from the objective lens side.

[1] – conversion lens for AT-B2

[2] – conversion lens for AT-B3/B4

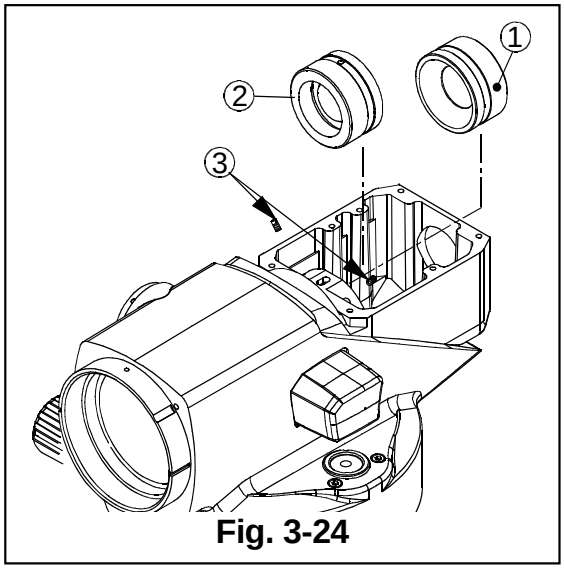


**Fig. 3-24**

**<Assembling >**

**(5)** Insert the conversion lens mounting tool A [4] from the objective lens side to the telescope frame.

**(6)** Insert the conversion lens [1] or [2] to the telescope frame. Pressing the conversion lens ([1] or [2] with the tool B [5], tighten the 2 conversion lens tube screws [3]. Apply the locking agent (S91) to the screws.

[1] – conversion lens for AT-B2

[2] – conversion lens for AT-B3/B4 (install the conversion lens with the hole "A" facing up) (☞ Fig. 3-26)

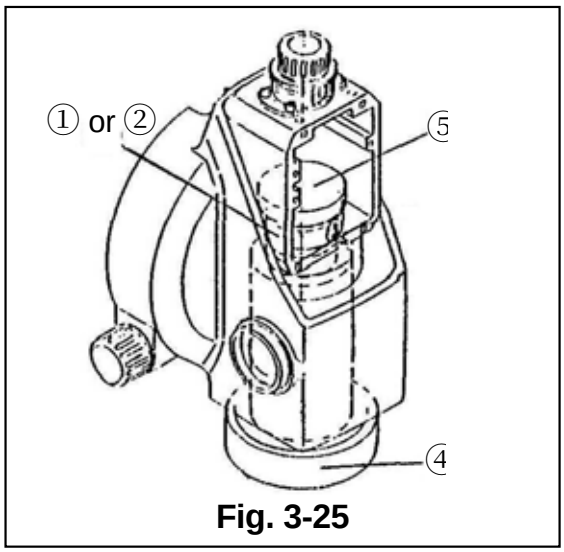


**Fig. 3-25**

**(7)** Relocate the focusing tube and pinion (☞ section 3.8 page 3-13).

**(8)** Relocate the objective lens (☞ section 3.7 page 3-11).

**(9)** Relocate compensator (☞ section 3.12 page 3-21).

**(10)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

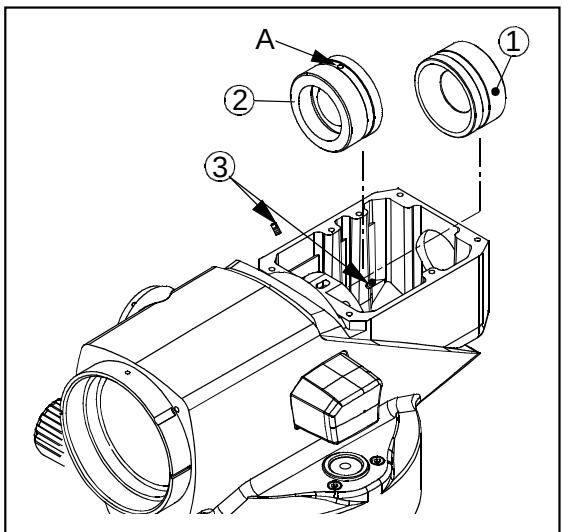


**Fig. 3-26**

# 3.10 EYEPIECE

The eyepiece of the AT-B2 is detachable and different from those of AT-B3 and AT-B4.

(AT-B2)

**<Disassembling>**

**(1)** Unscrew the reticle cover [1] ( with the sealing).

**(2)** Unscrew the eyepiece complete by rotating counterclockwise.

**(3)** Turn the eyepiece knob [2] fully clockwise. Loosen the 2 eyepiece knob set screws [3].

**(4)** Remove the eyepiece knob [2] from the eyepiece lens frame [4].

**(5)** Remove the eyepiece lens frame [4] together with the O-ring [6] from the eyepiece frame [11].

**(6)** Unscrew the eyepiece lens nut [10] from the eyepiece lens frame [4].

**(7)** Remove the eyepiece lens D [9], spacer [8], lens E [7] and sealing [5] from the eyepiece lens frame [4].

✍ If necessary remove the eyepiece sealing [12] from the eyepiece outer frame [13] and replace for a new one.

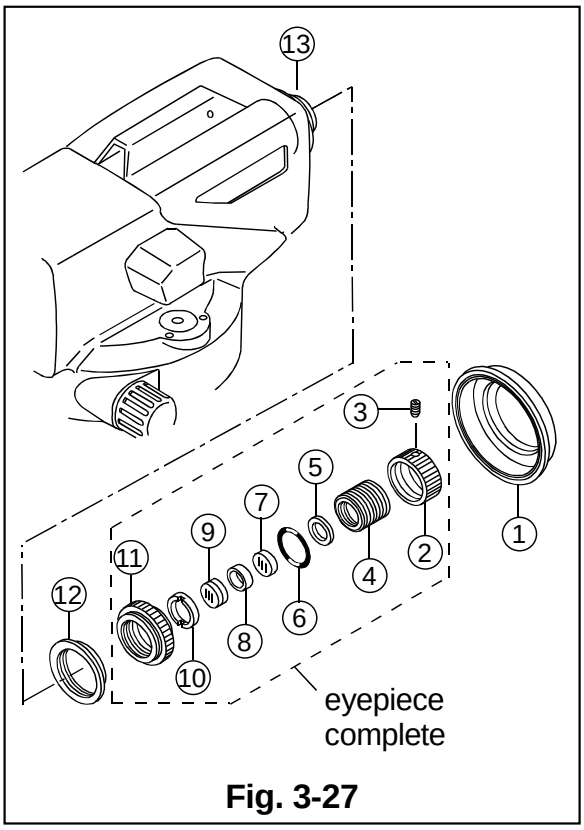



**Fig. 3-27**

**<Assembling >**

**(8)** Put the sealing [5], lens E [7], spacer [8] and lens D [9] into the eyepiece lens frame [4] (take care of the facing direction of the lens D and E).

**(9)** Install the eyepiece lens nut [10] into the eyepiece lens frame [4] to fix the lenses.

**(10)** Apply G32 to the O-ring [6] and eyepiece lens frame [4].

**(11)** Screw the eyepiece lens frame [4] fully clockwise to the eyepiece frame [11].

**(12)** Fit the eyepiece knob [2] and tighten the 2 set screws [3].

**(13)** Apply G31 to the eyepiece sealing [12] and screw the eyepiece complete into the eyepiece outer frame [13].

**(14)** Apply G31 to the sealing of the reticle cover [1].

**(15)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

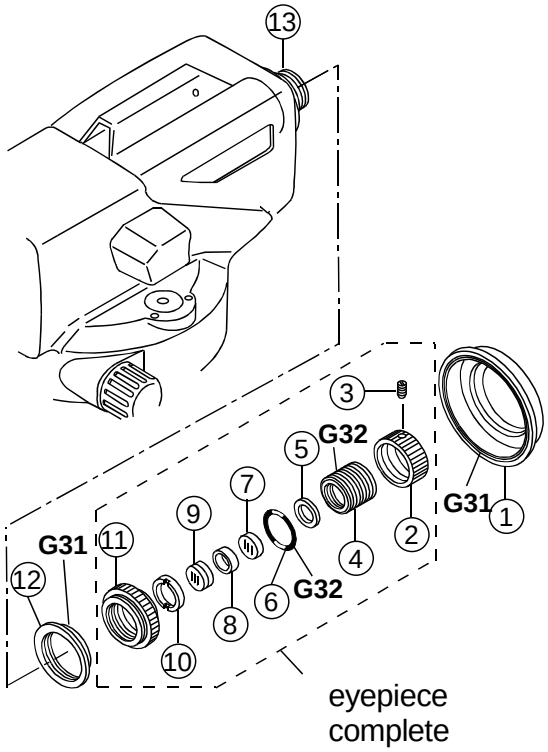



**Fig. 3-28**

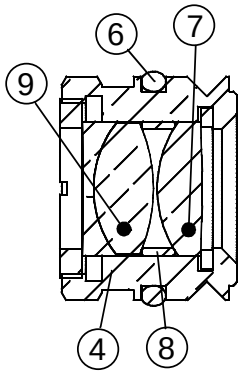



**Fig. 3-29**

(AT-B3/B4)

The eyepiece lens D [10], eyepiece lens E [8] and eyepiece knob [3] of the AT-B3 are different from those of the AT-B4.

**<Disassembling>**

**(16)** Unscrew the reticle cover [1] (with the sealing).

**(17)** Remove the eyepiece knob cover [2].

**(18)** Turn the eyepiece knob [3] fully clockwise and loosen the 2 set screws [4].

**(19)** Remove the eyepiece knob [3] from the eyepiece lens frame [5].

**(20)** Unscrew the eyepiece lens frame [5] together with the O-ring [7] from the eyepiece outer frame [13].

**(21)** Unscrew the eyepiece lens nut [11] from the eyepiece lens frame [5].

**(22)** Remove the eyepiece lens D [10], spacer [9], lens E [8] and sealing [6] from the eyepiece lens frame [5].

✍ If necessary, unscrew the 4 screws fixing the eyepiece outer frame [13] and remove the eyepiece outer frame [13] from the telescope frame.

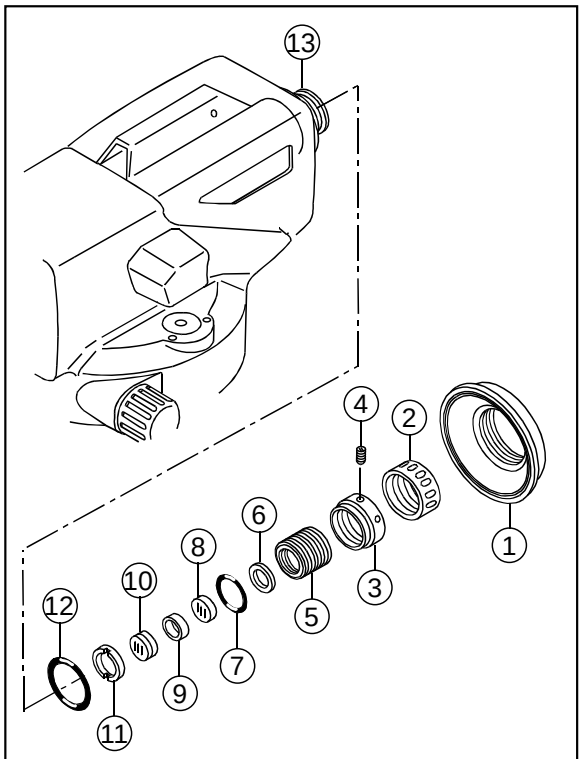



**Fig. 3-30**

**<Assembling >**

**(23)** Put the eyepiece lens sealing [6], lens E [8], spacer [9] and lens D [10] into the eyepiece frame [5] (take care of the facing direction of the lens D and E).

**(24)** Screw the eyepiece lens nut [11] to fix the lenses.

**(25)** Apply G32 to the O-ring [7] and eyepiece lens frame [5].

**(26)** Screw the eyepiece fully clockwise to the eyepiece outer frame [13].

**(27)** Fit the eyepiece knob [3] on the eyepiece lens frame [5] and tighten the 2 set screws [4].

**(28)** Put the eyepiece knob cover [2] on the eyepiece knob [3].

**(29)** Apply G31 to the sealing of the reticle cover [1].

**(30)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

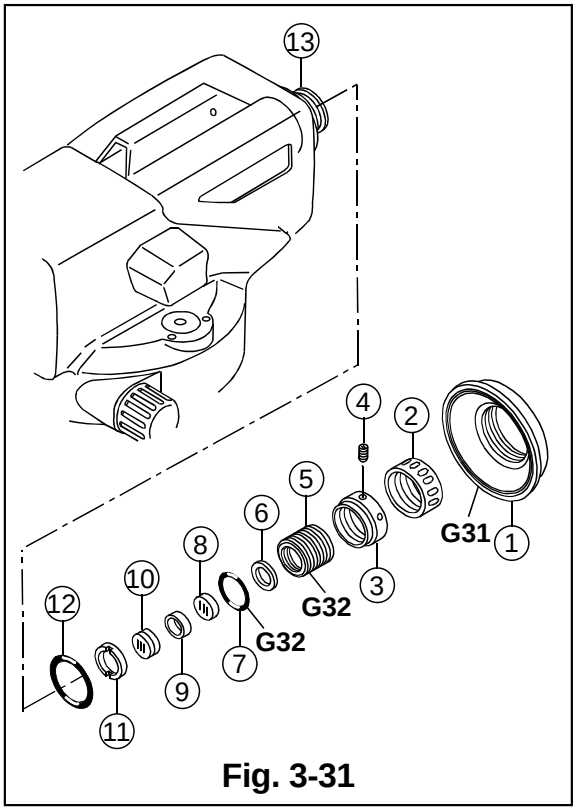



**Fig. 3-31**

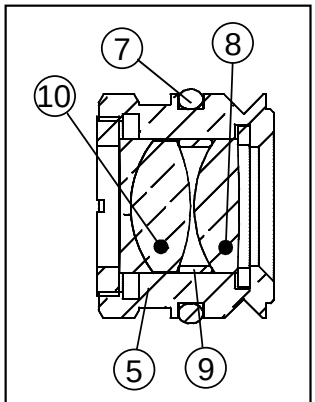



**Fig. 3-32**

# 3.11 RETICLE

The reticle ring [7] and reticle with frame [8] of the AT-BT2 are different from those of the AT-B3/B4.

**<Disassembling>**

**(1)** Unscrew the reticle cover [1] (with the sealing).

**(2)** Unscrew the 4 eyepiece outer frame screws [2] and remove the eyepiece complete with the outer frame [6].

**(3)** Unscrew the reticle retainer [10] from the eyepiece outer frame [6].

**(4)** Unscrew the reticle adjusting screw [5].

**(5)** Holding the reticle frame [8], unscrew the reticle screw [3] with the spring [4].

**(6)** Remove the O-ring [9], reticle with frame [8] and reticle ring [7] from the eyepiece outer frame [6].

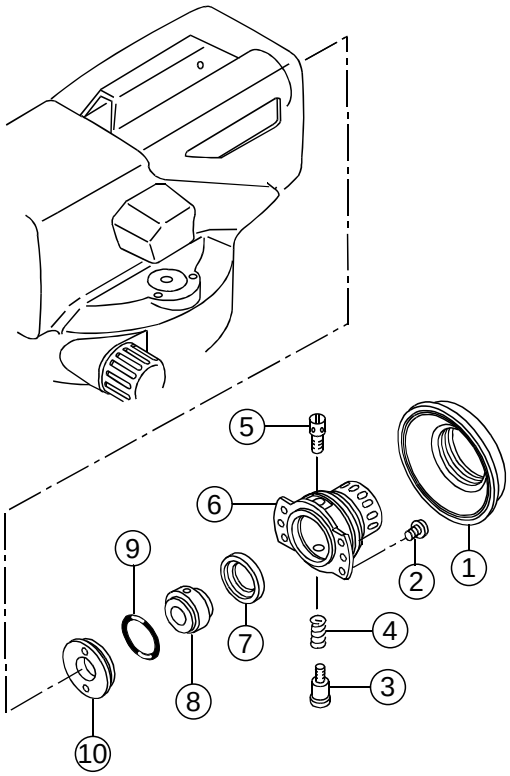



**Fig. 3-33**

**<Assembling >**

**(7)** Apply a small quantity of G38 to the reticle screw [3] and the thread of reticle adjusting screw [5].

**(8)** Put the reticle ring [7] and reticle with frame [8] into the eyepiece outer frame [6]. (Take care of the facing direction of the reticle with frame).

**(9)** Fix the reticle with frame [8] temporarily using the reticle adjusting screw [5].

**(10)** Insert and tighten the reticle screw [3] through the spring [4].

**(11)** Slip the O-ring [9] onto the reticle frame [8].

**(12)** Apply a small quantity of G31 to the front surface of the reticle retainer [10] (contact surface with the O-ring [9]). Install the reticle retainer [10], taking care not to jam the O-ring [9].

**(13)** Confirm that the reticle adjusting screw [5] smoothly turns.

**(14)** Apply the locking agent (S91) to the 3 points at the reticle retainer [10] and the eyepiece outer frame [6].

**(15)** Confirm that there is no stain and dust on the eyepiece lense. Relocate the eyepiece complete with the eyepiece outer frame on the telescope frame.

**(16)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

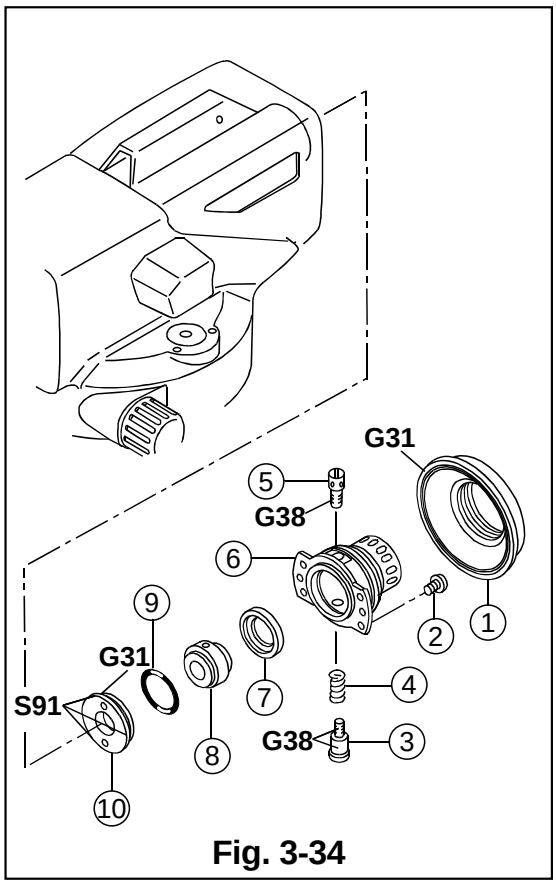



**Fig. 3-34**

# 3.12 COMPENSATOR

The compensator complete for each model AT-B2/B3/B4 is different.

**<Disassembling>**

**(1)** Unscrew the reticle cover [7] with sealing.

**(2)** Unscrew the 2 cover screws [1] and remove the cover [2].

**(3)** Unscrew the 4 compensator cover screws [3] and remove the compensator cover [4] with sealing.

**(4)** Unscrew the 3 compensator frame screws [5].

**(5)** Remove the compensator complete [6].

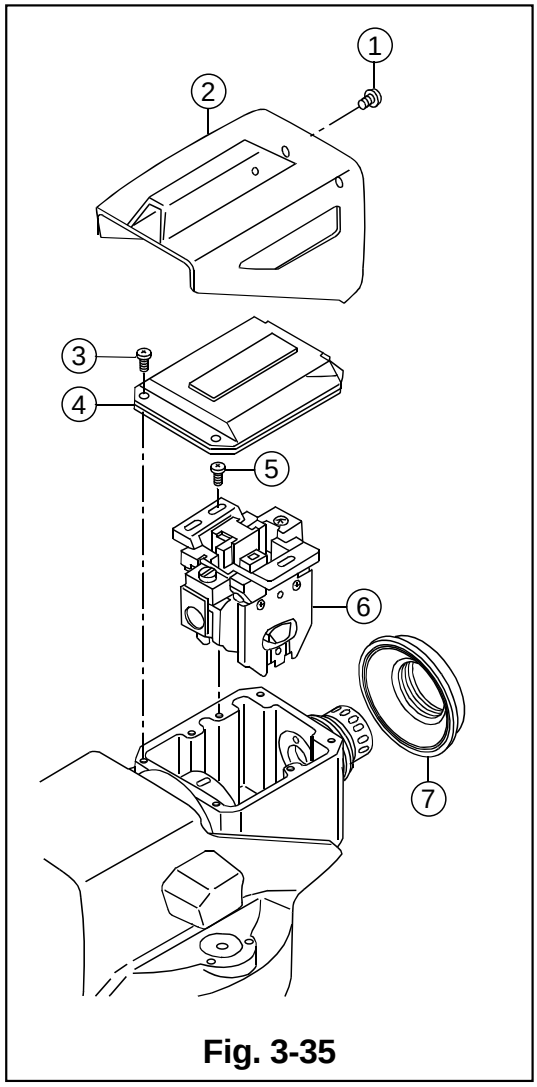



**Fig. 3-35**

**<Assembling >**

**(6)** Install the compensator mounting tool [8] on the telescope frame.

**(7)** Place the compensator complete [6] along with the compensator mounting tool [8] and tighten the 3 compensator frame screws [5] temporarily at the center of the screw holes.

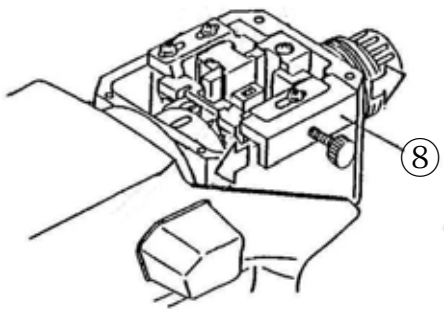



**Fig. 3-36**

**(8)** Proceed with the inspection and adjustment of the instrument (☞ chapter 5).

**<Caution>**

When the compensator unit is replaced for a new one, unscrew the 4 stop screws [9] (2 screws on each side) by $^{1}/_{4} \sim {}^{1}/_{2}$ of one full revolution and apply lac (S35) to the screws.

✍ The stop screws are tightened in the compensator supplied as a spare part to prevent the compensator suspension tapes from damages, which may occur while the unit is shipped from the factory.

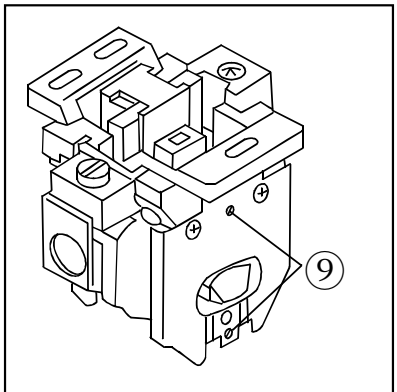



**Fig. 3-37**

# 3.13 FINDER

(AT-B2/B3)

**<Disassembling>**

**(1)** Unscrew and remove the reticle cover with the sealing.

**(2)** Unscrew the 2 cover fixing screws [1] and remove the cover [2].

**(3)** Loosen the finder set screw [5] and 2 screws [4].

**(4)** Pull out the finder from the cover [2].

**<Assembling >**

**(5)** Insert the finder complete into the cover taking care of the direction (the lens of the finder is the eyepiece side).

**(6)** Tighten the finder set screw [5] to fix the finder.

**(7)** Apply the locking agent [S91] to the finder set screw [5].

**(8)** Relocate the cover [2] and tighten the 2 cover screws [1]. Apply the locking agent [S91] to the screws.

**(9)** Apply G31 to the reticle cover sealing and install the reticle cover.

**(10)** Proceed with the adjustment of the finder (☞ section 5.2.19 page 5-23).

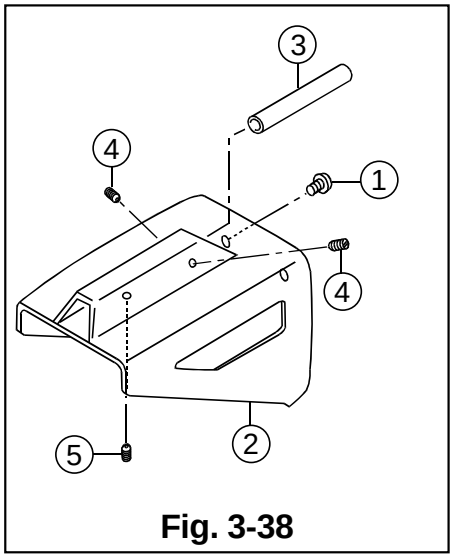



**Fig. 3-38**

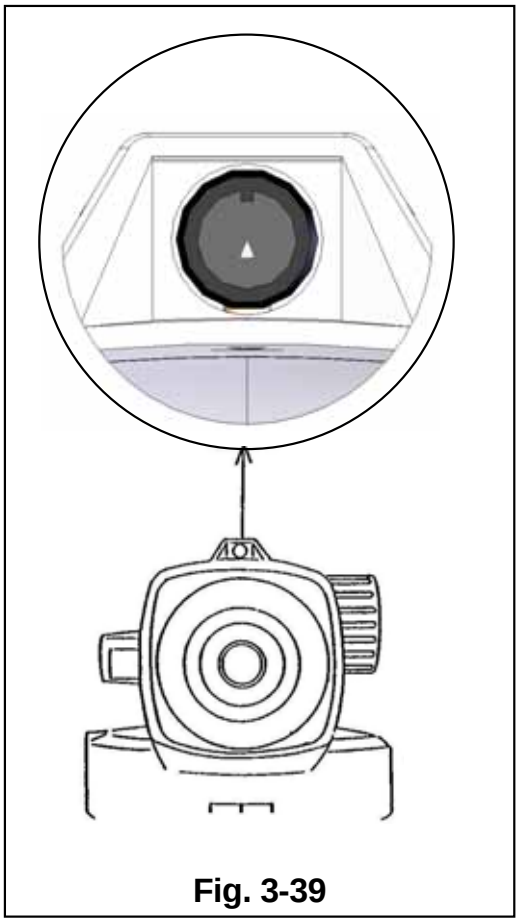


**Fig. 3-39**

# 4. SETTING UP THE COLLIMATORS

## 4.1 COLLIMATOR SYSTEM SETUP

The collimator system is the equipment, which can be used to inspect the vertical axis, the horizontal axis, the sighting axis (the level axis) of the instruments.

Standard collimator system recommended by the JSIMA114: 2002 ("Guideline for the Checks and Adjustments of the Collimator System for Surveying Instruments") comprises of the 4 collimators. The 2 of them are installed for the level lines (A, B) and the other two (C, D) are installed above and below the collimator B.

Infinite (∞) parallel rays are obtained through the collimators. Non-infinite rays are also available from the collimator A. Collimators A and B optical axes are aligned in a straight line and remain level.

Collimators C and D are mounted at 30° in elevation and in depression, respectively, in the same vertical plane.

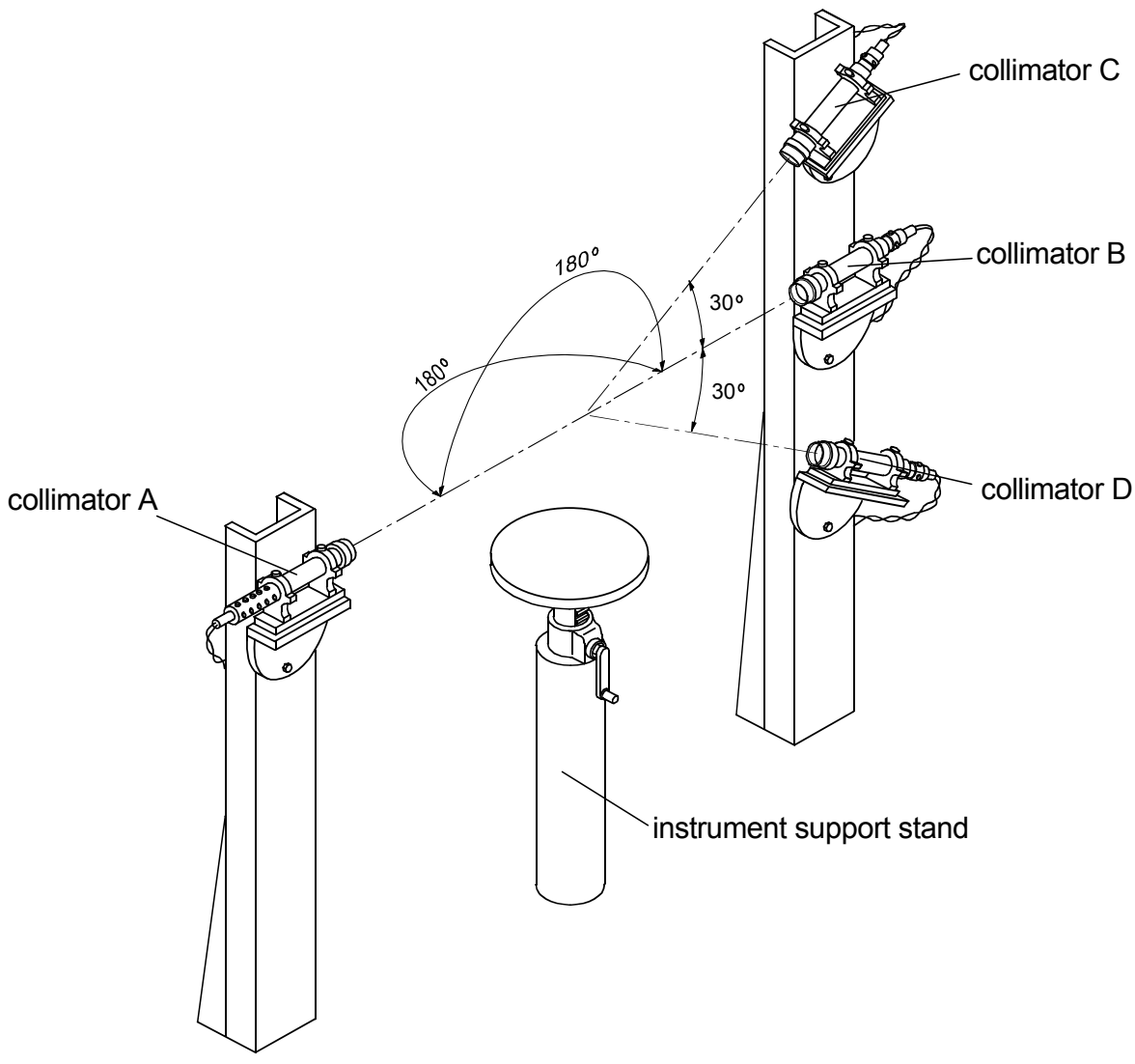



**Fig. 4-1**

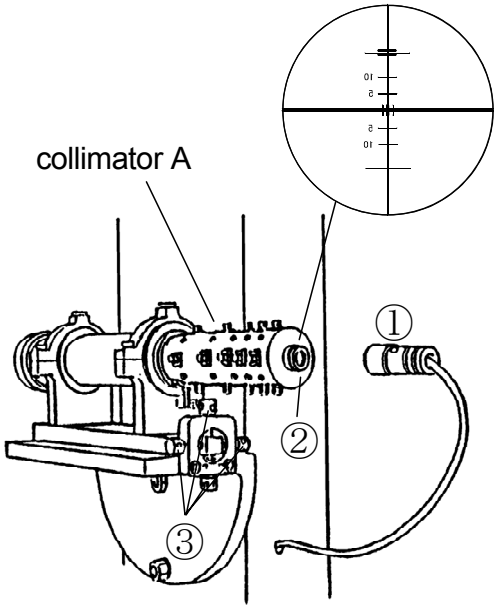
# 4.2 INSPECTION OF COLLIMATORS

Prior to the inspection of the instruments, check the collimators A and B if they are in line with each other and horizontal.

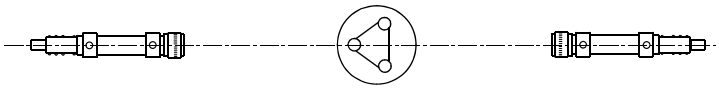
**<Inspection>**

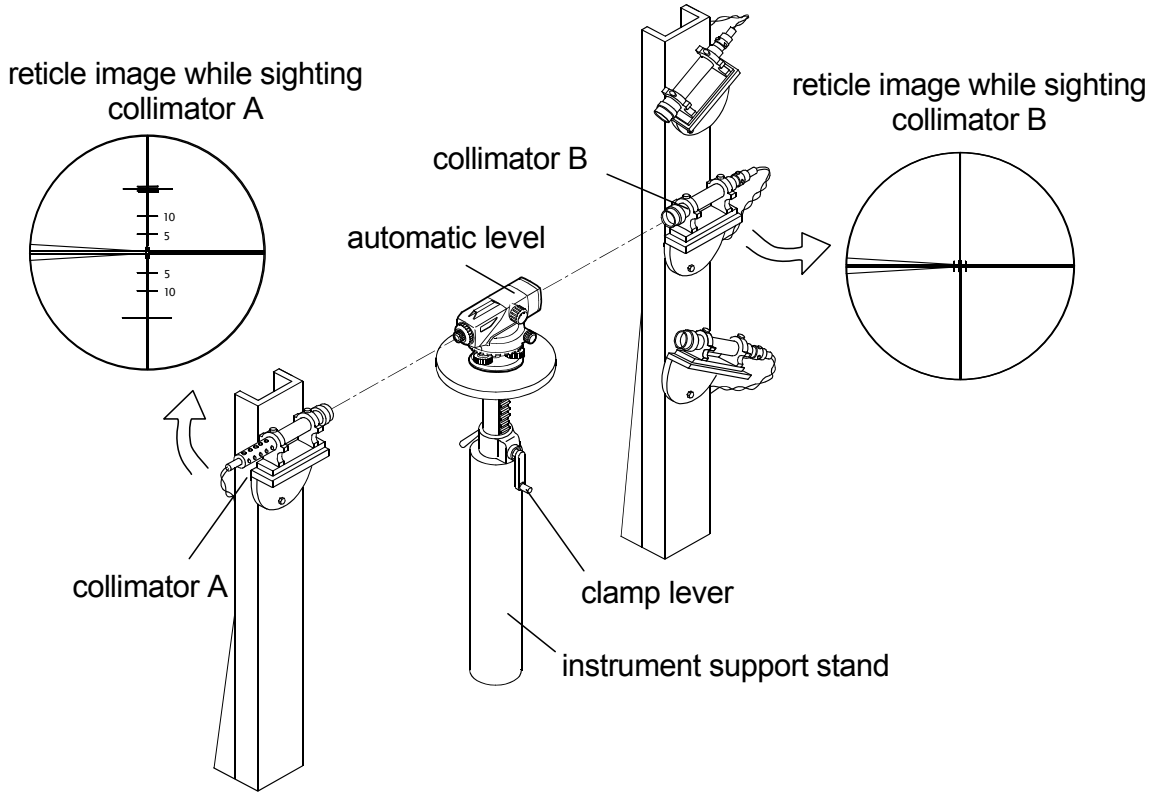
**(1)** Remove the illuminator ① from the eyepiece of the collimator A. Looking through the eyepiece ② of the collimator A, move the eyepiece knob back and forth to focus on the reticles of the collimators A and B.

**(2)** By using the collimator tilt adjusting screws ③, align the reticle of the collimator A to that of collimator B. Relocate the illuminator.




**(3)** Place an adjusted automatic level on the instrument support stand and level the instrument.



**(4)** Sight the 2m reticle of the collimator A and adjust the instrument height to align the horizontal lines of both instrument and collimator reticles. Fix the the instrument height by the clamp lever.

**(5)** Re-level the instrument.

**(6)** Sight the collimators A and B to check if the sighting axis of the automatic level is horizontal. If any error is observed, adjust the horizontal reticle adjusting screw.

✍ If the collimators A and B are not horizontal and the sighting axis of the automatic level is horizontal, the errors are symmetrically reversed when sighting the collimator A and then B.

**(7)** Using the reference automatic level, confirm the horizontality of the collimators A and B.

**<Adjustment>**

**(8)** Sight the collimator B with the adjusted automatic level and observe the horizontal lines of the intrument and collimator reticles.

**(9)** By using the collimator B tilt adjusting screws, align the horizontal reticles.

**(10)** Repeat steps from (1) to (7) to complete adjustment.

# 5. INSPECTION AND ADJUSTMENT

## 5.1 SUMMARY OF INSPECTION

* Inspection recommended for the new instruments as a pre-delivery check

In the table below collimator A is the collimator equipped with the 2m (or 3m), 5m and 10m distance reticles and including the infinity (∞) reticle with stadia lines, collimator B is the horizontal collimator with the infinity (∞) reticle.

| No. | Inspection Item | Specification | | | Inspection Procedure |
|---|---|---|---|---|---|
| | | AT-B2 | AT-B3 | AT-B4 | |
| *1 | External appearance check | ---- | | | Confirm visually that the optical units and the outer sections of the instrument are clean, without damages, dust and dirt |
| *2 | Rotating/moving parts function check | ---- | | | Confirm smoothness of rotation/movement of the instrument units |
| 3 | Magnification (1) | 32x ± 5% | 28x ± 5% | 24x ± 5% | Place the scale on the objective lens and read the scale using dynameter |
| 4 | Aperture (1) | ø42mm ± 10% | ø36mm ± 10% | ø32mm ± 10% | Focus the telescope to infinity (∞). Measure the field of view using dynameter and multiply it by the magnification |
| 5 | Resolving power (2) | 3.0” or less | 3.5” or less | 4.0” or less | Use the resolution test chart |
| *6 | Circular level | ---- | | | After levelling in one position turn the instrument 180° and confirm the bubble centering |
| *7 | Minimum focus | 0.3m or less | | | Sight the target at a distance of 0.3m and confirm that the image is sharply focused |
| *8 | Inclination of reticle and horizontality of line of sight | 5” or less | | | Check sighting collimator B |
| *9 | Stadia ratio (1) | ±0.4% (total width ±8”) or less | | | Check the stadia lines sighting collimator A |
| *10 | Sighting axis deviation (2) | 0.3mm or less | | 0.5mm or less | Focus on collimator A 2m, 5m and 10m reticles and read the difference in reticle graduations in vertical direction |

| No. | Inspection Item | Specification | | | Inspection Procedure |
|---|---|---|---|---|---|
| | | AT-B2 | AT-B3 | AT-B4 | |
| *11 | Automatic compensation accuracy (2) (front to back tilt) | ±5” or less | ±10” or less | | Sight collimator B and tilt the instrument ±15’ in front to back direction. Check horizontality of line of sight |
| 12 | Automatic compensation accuracy (left to right tilt) (2) | ±5” or less | ±10” or less | | Sight collimator B and tilt the instrument ±15’ in left to right direction. Check horizontality of line of sight |
| 13 | Automatic compensation range (2) (front to back tilt and left to right tilt) | Range: ±16’ or more<br>Diff. between upper and lower bounds: 4’ or less | | | Sight collimator B and tilt the instrument until reticle stops going back to center |
| 14 | Eccentricity of horizontal circle (2) | 15’ or less | | | Check the eccentricity sighting collimators A and B |
| *15 | Horizontal accuracy (horizontality of line of sight (2) | 5” or less | | | Check using collimator A or B |
| 16 | Finder accuracy | 10’ or less | | ---- | Check sighting the target at a distance of more than 10m |

(1) The inspection tolerances are in accordance with requirements of Japanese Surveying Instruments Manufacturers’ Association standard: JSIMA 103: 2007 (“Levels”). Standards for the AT-B2/B3 levels are within application category B and standards for the AT-B4 levels are within application category D.

(2) The inspection tolerances comply with the manufacturer standard. Although the inspection procedures are same as those of JSIMA 103: 2007 standard, the specified accuracy of the check items is higher.

✍ The collimators are setup and adjusted according to Japanese Surveying Instruments Manufacturers’ Association standard: JSIMA 114: 2002 (“Guideline for the Checks and Adjustments of the Collimator System to Surveying Instruments”)

# 5.2 INSPECTION AND ADJUSTMENT PROCEDURES

## 5.2.1 EXTERNAL APPEARANCE CHECK

**(1)** Check visually that the outer sections of the instrument are clean. Check the painted and plastic parts for any damages, scratches, etc.

**(2)** Confirm that the optical units are clean (objective lens, eyepiece, inner optical parts as seen through the objective lens).

## 5.2.2 ROTATING PARTS FUNCTION CHECK

**(1)** Check to confirm smoothness of rotation of the AT-B2/B3/B4 units: focusing knob, eyepiece knob, horizontal fine motion screw and levelling screws.

✍ The rotation torque for the levelling screws as checked in the factory by using the special tension gauge is 0.35~0.50N (35~50gf).

**(2)** Turn the telescope to verify smooth rotation of the vertical axis.

✍ If any abnormality is supposed to occur, confirm the vertical axis torque within standard 150g ~ 280g. Check the torque inspecting the telescope at the eyepiece.

## 5.2.3 TELESCOPE MAGNIFICATION

**(1)** Focus the instrument on the infinity (∞) reticle of the collimator.

**(2)** Attach the dynameter tool [1] on the eyepiece and focus on the tool scale.

**(3)** Place a scale [2] on the objective lens. Measure the reading of the scale (I) corresponding to the reading of the dynameter (E).

**(4)** Calculate the telescope magnification (I/E).

**(5)** Calculate the tolerance: (A-B)/B x 100
A – Magnification calculated in the above step (3)
B – Magnification in the specification

**Tolerance:**
**± 5%**

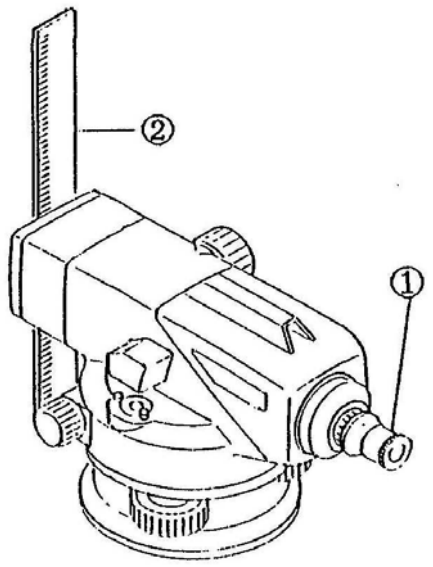



**Fig. 5-1**

[Example]

Dynameter : 10 graduations (1mm)
Scale : 30.0mm
Magnification : 30.0/1.0 = 30

**(1)** The minimum graduation of the dynameter is 0.1 mm.

**(2)** When the magnification is out of tolerance, check the objective lens and eyepiece lens if they are correct parts for the instrument.

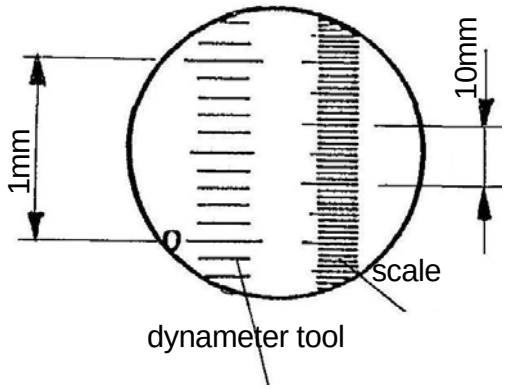



**Fig. 5-2**

## 5.2.4 TELESCOPE APERTURE

Proceed with this inspection after checking "5.2.3 Telescope Magnification" in succession.

**Tolerance:**
**± 10%**

**(1)** Confirm that the telescope is focused to the infinity (∞).

**(2)** Place the dynameter on the eyepiece. Looking through the dynameter, measure the visual field with the scale of dynameter.

**(3)** Calculate the tolerance:
tolerance = (A x C – D)/D x 100
A = magnification calculated in section 5.2.3
C = reading of the dynameter scale measured in the above step (2)
D = objective lens aperture in the specifications

**(4)** When the telescope aperture is out of the tolerance, check the objective lens if it is correct part for the instrument.

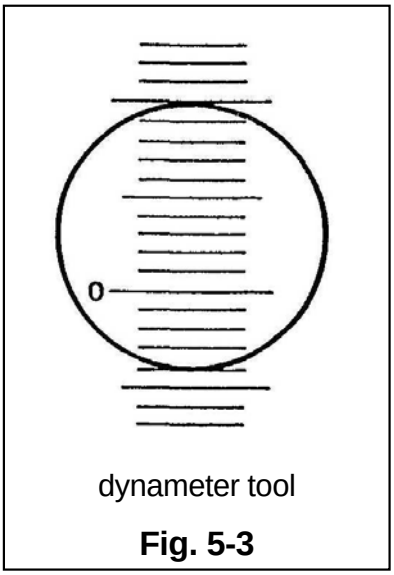



**Fig. 5-3**

## 5.2.5 TELESCOPE RESOLVING POWER

**(1)** Place an inspection chart for the resolving power (3”, 3.5”, 4”) at an equivalent distance to the stripes on the chart.

**(2)** Looking through the eyepieces observe the vertical, horizontal and oblique stripes to check if every stripe can be recognized at the center of the view field (i.e. within circle of one half of the view field).

**(3)** When the resolving power is out of the tolerance, check that there is no dust and dirt on the optical parts of the instrument. Check if the optical units are the correct parts for the instrument.

**Tolerance:**
**AT-B2 : ±3” or less**
**AT-B3 : ±3.5” or less**
**AT-B4 : ±4” or less**

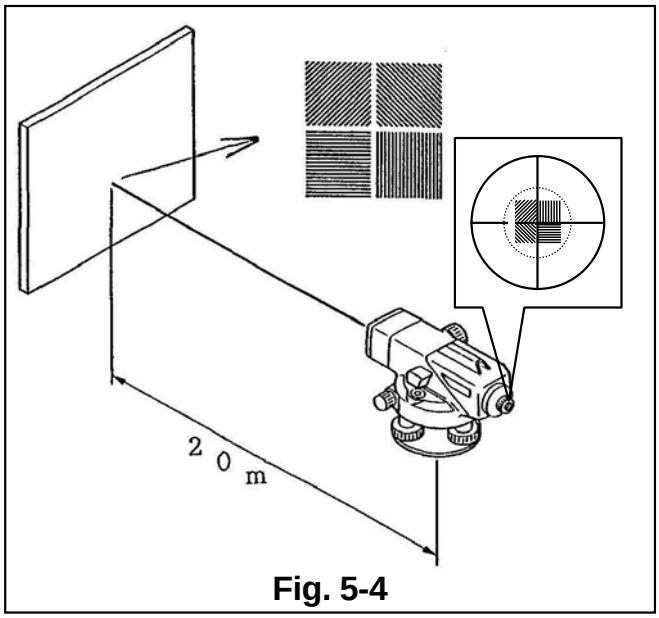



**Fig. 5-4**

## 5.2.6 CIRCULAR LEVEL

**<Inspection>**

**(1)** Place the test level [1] on the instrument.

**(2)** Center the level vial by using the adjusting screw [2] of the test level.

**(3)** Rotate the telescope frame 180°

**(4)** When the level vial is out of center, correct half of the displacement using the levelling screws [3] and [4], and another half with the adjusting screw [2] of the test level.

**(5)** Rotate the telescope frame 90°. When the level vial is not centered, correct the displacement using the levelling screw [5].

**(6)** Repeat steps 3 to 6 to center the level vial at any direction of the telescope frame.

**(7)** Check the position of the circular level vial.

**<Adjustment>**

**(8)** Using the hexagonal wrench (2mm) center the circular level vial with the 2 adjusting screws [6], [7]. The level vial moves with the adjusting screw [6] or [7].

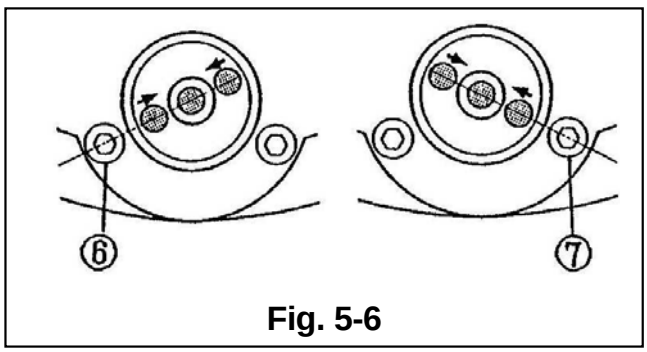



**Fig. 5-6**

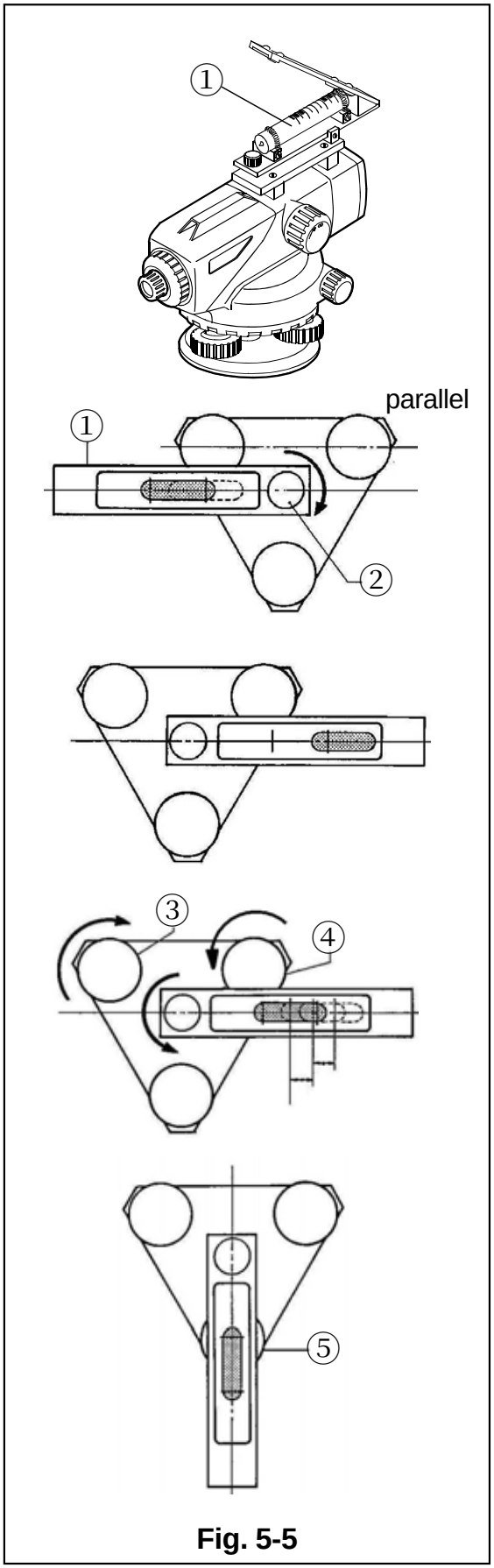



**Fig. 5-5**

Optional adjustment without test level:

Adjust the levelling screws to center the bubble in the circular level.

**(2)** Turn the instrument 180° (or 200 gon).

If the bubble is inside the circle, no adjustment is necessary. If the bubble shifts from within the circle, adjust as follows:

**(3)** Compensate for one-half of the shift by adjusting the levelling screws.

**(4)** Eliminate the remaining half shift with the circular level adjusting screws using the hexagonal wrench.

**(5)** Turn the instrument 180° (or 200 gon). If the bubble remains in the circle, adjustment is complete.

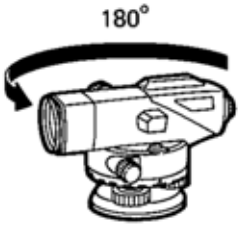



**Fig. 5-7**

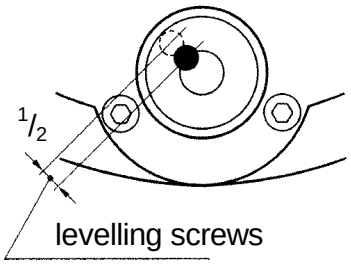



**Fig. 5-8**

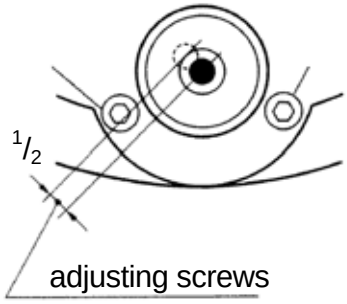



**Fig. 5-9**

# 5.2.7 INSPECTION WITH COLLIMATORS – PREPARATION

Prepare the following tools:

- Collimator system
- Inclining stage (optional equipment)

**(1)** Level the collimators A and B and align their optical axes (☞ section 4.2, page 4-2).

**(2)** Place the AT-B2/B3/B4 on the instrument support stand, so that one of the levelling screws is pointing towards collimator A. Bring the instrument to the collimator height and tighten the fixing clamp.

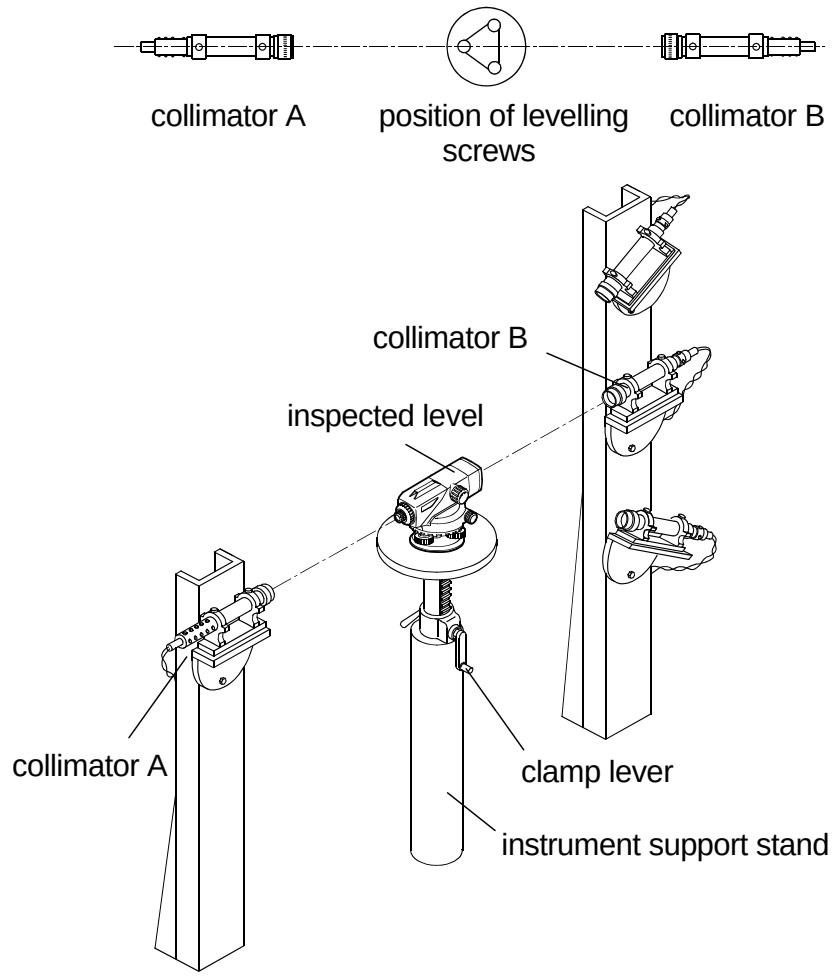



**Fig. 5-10**

Option:

To check the accuracy and range of the compensator, the test level (S055-001) can be used or optionally the inclining stage (ST-RA-03) can be applied. If the inclining stage is available by the service center, it is recommended to use it taking into consideration the convenience of its operation.

- Place the inclining stage on the instrument support stand in this manner that one of the test level vials is parallel to the optical axes of the collimators (another one is perpendicular to the optical axes).
- Place the AT-B2/B3/B4 on the inclining stage so that one of the levelling screws is pointing towards collimator A. Bring the instrument to the collimator height and tighten the fixing clamp.

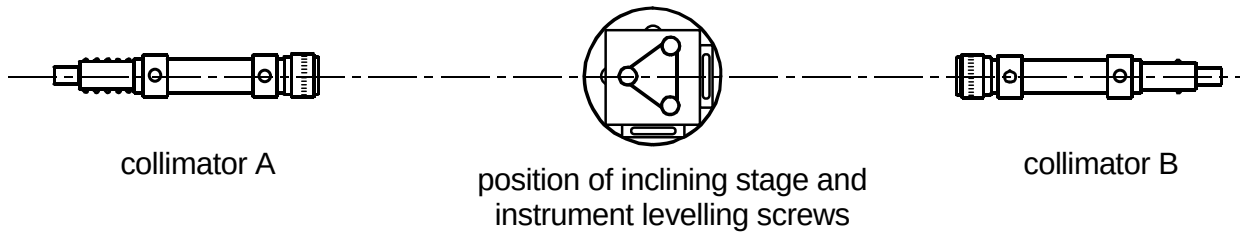



**Fig. 5-11**

## 5.2.8 MINIMUM FOCUS DISTANCE

**<Inspection>**

**(1)** Place the instrument on the collimator support stand. Bring the unit to the collimator A height and tighten the fixing clamp. Level the instrument.

**(2)** Place an object (scale etc.) at a distance of 0.3m from the instrument center. Turn the focusing knob and check if the instrument can be focused on the object.

**(3)** Focus the instrument to infinity (∞) and confirm that the focusing knob has a proper amount of play.

**Tolerance:**
**0.3m or less**

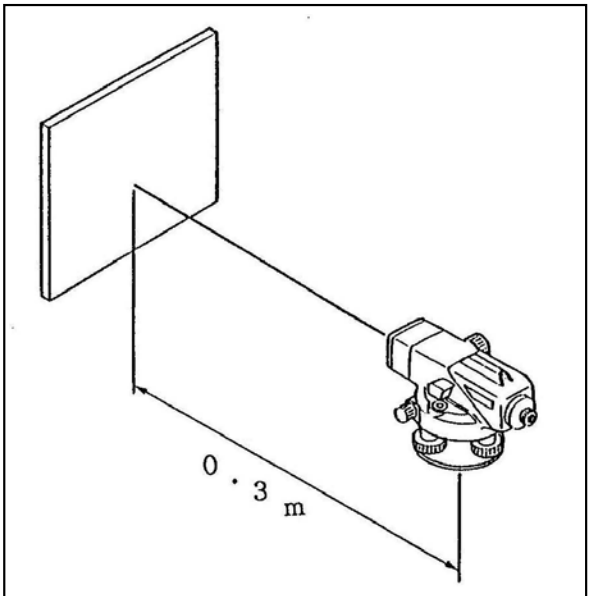



**Fig. 5-12**

**<Caution>**

The focusing range is determined by the engagement of the pinion (focusing knob) with the focusing tube (☞ section 3.8 page 3-13).

# 5.2.9 INCLINATION OF RETICLE

**<Inspection>**

**Tolerance:**
**5” or less**

**(1)** Sight the collimator B. Turn the horizontal fine motion screw until the end of the left side of the instrument reticle is on the center part of the collimator B reticle.

✍ If the end of the instrument reticle is not aligned with the collimator reticle, adjust the instrument reticle adusting screw (☞ Fig. 5-16 on the following page).

**(2)** Turn the horizontal fine motion screw until the end of the right side of the instrument reticle is on the center part of the collimator B reticle. Check the displacement of the instrument reticle from the position in the above step (1).

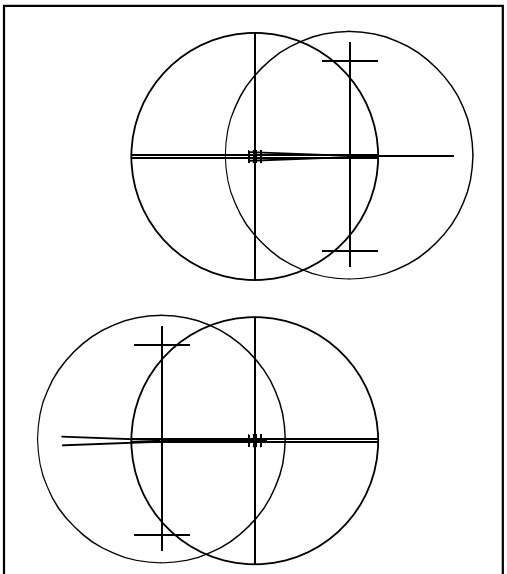


**Fig. 5-13**

**<Adjustment>**

**(3)** Loosen the 4 eyepiece outer frame screws [1]. Turn the eyepiece outer frame to remove half of the displacement.

**(4)** Reconfirm adjustment of steps (1) and (2).

**(5)** Tighten the eyepiece outer frame screws [1] with torque of 2.4 ± 0.5 kgf･cm (0.24 ± 0.05 N･m) and apply the locking agent (S91) to the screws.

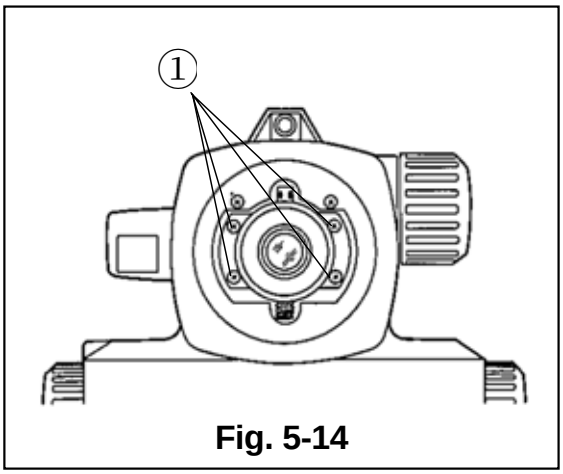



**Fig. 5-14**

## 5.2.10 LINE OF SIGHT

Height of the horizontal reticle

**<Inspection>**

**(1)** Sight the collimator A and confirm that the instrument is set to the proper height. Re-level the instrument and sight the collimator A or B.

**(2)** Observe the instrument reticle and tube of the collimator with the right and left eyes in turn. Keep your eyes horizontal. Check if the horizontal reticle is within adjusting range as shown in Fig. 5-15.
If out of the tolerance, proceed with the adjustment below.

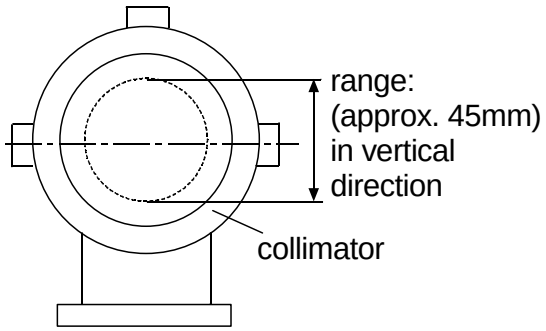



**Fig. 5-15**

**<Adjustment>**

**(3)** Remove the reticle cover and adjust the reticle adjusting screw [1] using the adjusting pin.

**<Caution>**

**(4)** During the above inspection keep your eyes horizontal.

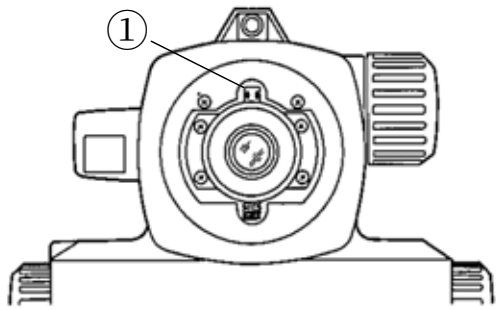



**Fig. 5-16**

Horizontality of the line of sight

**Tolerance:**
**5” or less**

**<Inspection>**

**(5)** Sight the collimator A or B infinity reticle (∞) and check the error.

[Adjustment when the error is within 30”]

**(6)** Remove the reticle cover and adjust the reticle adjusting screw [1] (☞ Fig. 5-16) to align the reticles.

[Adjustment when the error is more than 30”]

**(7)** Remove the cover and the compensator cover.

**(8)** Slightly loosen the prism frame fixing screw [2].

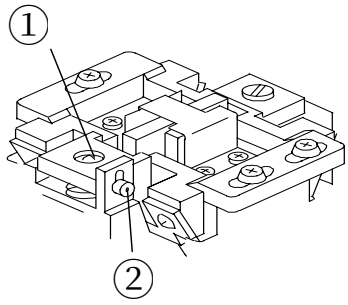



**Fig. 5-17**

**(9)** Adjust the prism frame adjusting screw [1] to have the sighting axis horizontal [±30”]. Tighten the prism frame fixing screw [2] with torque of 1.2 ± 0.3 kgf·cm (0.12 ± 0.03 N·m) and reconfirm that the line of sight is still horizontal.

**(10)** Apply the locking agent (S91) to the screws [1] and [2].

**(11)** Relocate the compensator cover and install the cover on the telescope frame (if the compensator accuracy and range is to be inspected and adjusted, as described is sections 5.2.13~5.2.16, reassemble the instrument later after final checking).

**(12)** Adjust the reticle adjusting screw to align the reticles and reconfirm the inclination of the reticle (☞ section 5.2.9).

## 5.2.11 STADIA RATIO

**<Inspection>**

**Tolerance:**
**±8” or less**
**within ±0.4%**

**(1)** Sight the collimator A infinity (∞) reticle and using the reticle adjusting screw, move the reticle of the instrument until the stadia line is centered between the upper double lines of the collimator A.

**(2)** Check if the lower stadia line is aligned with the lower line.

✍ The width of the Topcon’s collimator reticle lines is 3” and the distance between the center horizontal double lines is 20”.

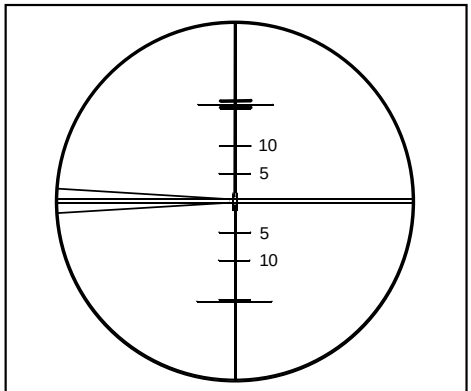


**Fig. 5-18**

**<Adjustment>**

**(3)** Remove the objective lens frame cover and objective lens outer frame (☞ section 3.7 page 3-10).

(AT-B2)

**(4)** Loosen the stadia adjusting nut [2] using the stadia ring mounting tool [1].

**(5)** Rotate the objective lens complete [3] until the stadia ratio is within the tolerance (e.g. rotate the objective lens clockwise to widen the interval of the 2 stadia lines).

**(6)** Tighten the stadia adjusting nut using the stadia nut mounting tool [1] and recheck the stadia ratio.

**(7)** Apply the locking agent (S91) to the nut [2].

**(8)** Relocate the objective lens outer frame and objective lens frame cover (☞ page 3-11).

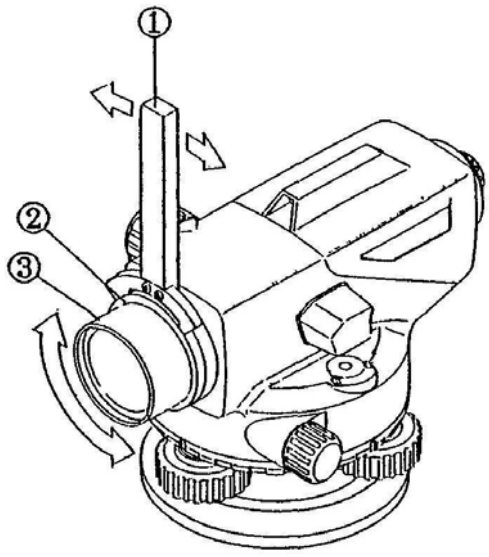


**Fig. 5-19**

(AT-B3/B4)

**(9)** Loosen the objective lens set screw [4] using the hexagonal wrench.

**(10)** Rotate the objective lens complete [5] until the stadia ratio is within the tolerance (e.g. rotate the objective lens clockwise to widen the interval of the 2 stadia lines).

**(11)** Tighten the objective lens set screw [4] using the hexagonal wrench and recheck the stadia ratio.

**(12)** Apply the locking agent (S91) to the screw [4].

**(13)** Relocate the objective lens outer frame and objective lens frame cover (☞ page 3-11).

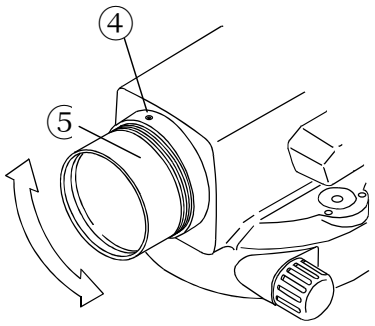



**Fig. 5-20**

## 5.2.12 SIGHTING AXIS DEVIATION

Caution: The collimator A ∞, 10m, 5m and 2m reticles must be aligned horizontal in advance.

**Tolerance:**
**AT-B2/B3: 0.3mm or less**
**AT-B4: 0.5mm or less**

**(1)** Level the instrument and sight the infinity (∞) reticle of the collimator A. Confirm alignment of the horizontal reticles. If there is a displacement, adjust the instument reticle adjusting screw (☞ Fig. 5-16 page 5-11).

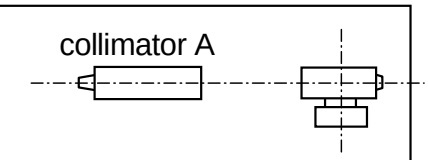



**Fig. 5-21**

**(2)** Focus on the collimator 2m reticle and adjust the instrument height to align precisely both horizontal reticles of the collimator and AT-B2/B3/B4.

**(3)** Focus on the collimator 5m and 10m reticles in turn and read the difference in Y (vertical) reticle graduations from the instrument horizontal reticle. The reticles of Topcon's collimators are graduated to the increment values shown in the following table:

| COLLIMATOR RETICLE | GRADUATION INTERVAL |
|---|---|
| 2m | 0.5mm |
| 5m | 0.5mm |
| 10m | 0.5mm |

**(4)** Make sure that both difference readings (at 5m and 10m reticles) are within the standard.

**(5)** If the sighting axis deviation is out of the tolerance, replace the focusing tube or the telescope frame.

# 5.2.13 ACCURACY OF COMPENSATION (TILT RESIDUAL) (FOR FRONT TO BACK TILT)

**<Inspection>**

**Tolerance (at ±15'):**
**AT-B2 : ±5" or less**
**AT-B3 : ±10" or less**
**AT-B4 : ±10" or less**

**(1)** Place the test level [1] (☞ Fig. 5-22) on the telescope frame and precisely leve1 the instrument observing the bubble of the test level [1] vial.

**(2)** Sight the collimator B. If necessary, using the instrument reticle adjusting screw, align the horizontal reticles.

**(3)** Turn the levelling screw [2] in line with the collimator A to tilt the instrument +15' in the front to back direction observing the bubble of the test level vial. Check if the displacement of the reticle is within the tolerance.

**(4)** Tilt the instrument -15' in the same manner as the above step (3). Check the displacement ot the instrument reticle.

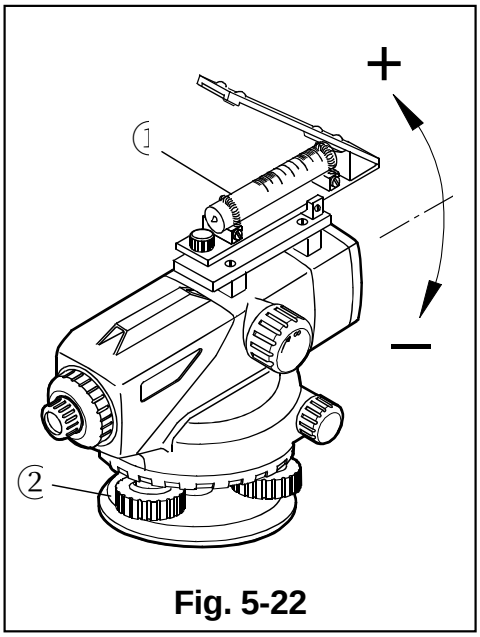



**Fig. 5-22**

✍ If the incling stage is used, tilt the incling stage observing the bubble of the incling stage level vial.

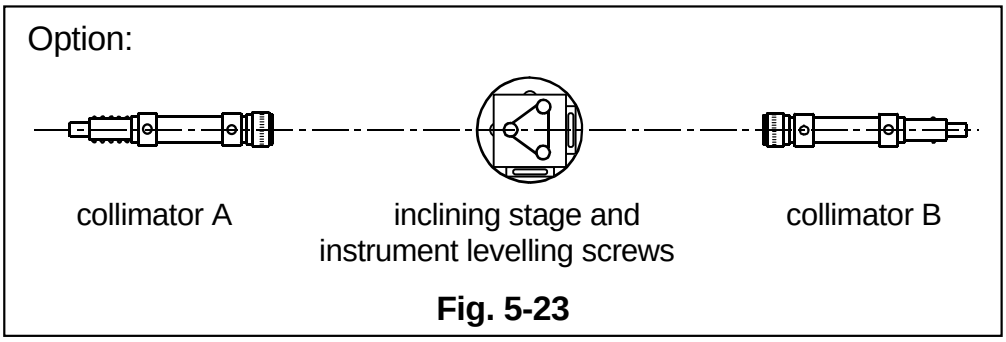



**Fig. 5-23**

**<Adjustment>**

**(5)** Remove the cover and the compensator cover (☞ section 3.12 page 3-21).

**(6)** Install the compensator mounting tool [5] on the telescope frame. Loosen the 3 compensator frame screws [3]. Move the compensator complete along the tool back and forth to remove the displacement at a ±15'.

**(7)** Tighten the compensator frame screws with torque of 2.4 ± 0.5 kgf·cm (0.24 ± 0.05 N·m).

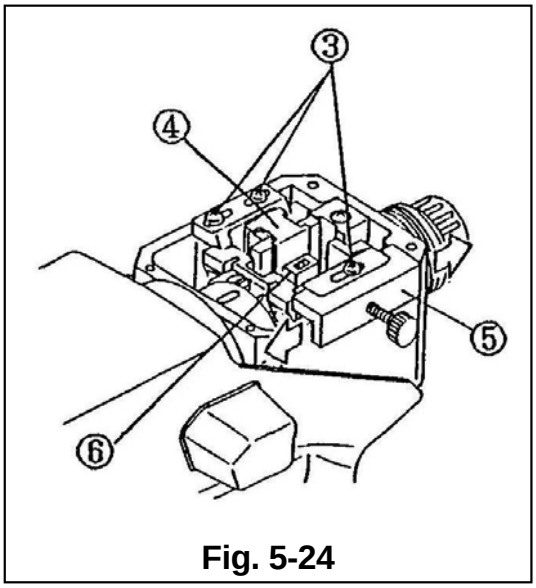


**Fig. 5-24**

**<Caution>**

When the compensator is moved to the objective lens side, the tilt residual changes to the minus direction at +15', (plus direction at -15').
If the compensator does not work at ±15', adjust the compensator stopper position [6] (☞ section 5.2.15).

✍ If the compensator accuracy cannot be adjusted within the tolerance, attach the balancer(s) (☞ Fig. 6-4 page 6-6) to the damping plate of the compensator mirror frame.

## 5.2.14 ACCURACY OF COMPENSATION (TILT RESIDUAL) (FOR LEFT TO RIGHT TILT)

**<Inspection>**

**Tolerance (at ±15'):**
**AT-B2 : ±5" or less**
**AT-B3 : ±10" or less**
**AT-B4 : ±10" or less**

**(1)** Place the test level on the telescope frame and precisely leve1 the instrument observing the bubble of the test level vial.

**(2)** Sight the collimator B. Using the instrument reticle adjusting screw, align the horizontal reticles.

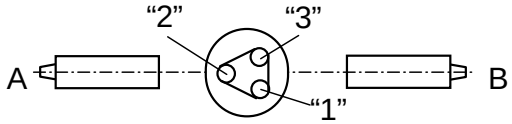


**Fig. 5-25**

**(3)** Turn the telescope frame 90° and rotate the 2 levelling screws "1" and "3" (☞ Fig. 5-25) by the same amount in the opposite rotation directions to tilt the instrument +15' in the left to right direction observing the bubble of the test level vial. Then resight the collimator B (if necessary turn the levelling screw "2" to relevel the instrument in the front to back direction and recheck the left to right direction).

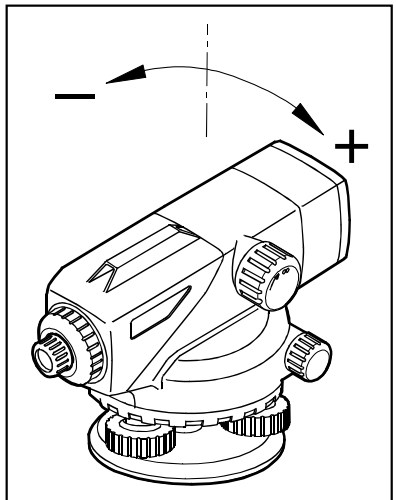


**Fig. 5-26**

**(4)** Resight the collimator B. Check if the displacement of the reticle is within the tolerance.

**(5)** Tilt the instrument -15' in the left to right direction using the same method as the above steps (3) and (4). Check that the displacement between the instrument and collimator horizontal reticles is within the tolerance.

✍ To tilt the instrument in more simple way, the levelling base can be turned 90° on the instrument support stand in advance. While the 2 levelling screws (i.e. the line passing through the center of the levelling screws) are set parallel to the optical axes of the collimators, the levelling screw "1" (☞ Fig. 5-27) can be used to incline the instrument in the left to right direction.

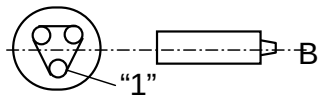



**Fig. 5-27**

✍ If the incling stage is used (☞ Fig. 5-28) tilt the incling stage in the direction perpedicular to the optical axes of the collimators A and B observing the bubble of the inclining stage level vial.

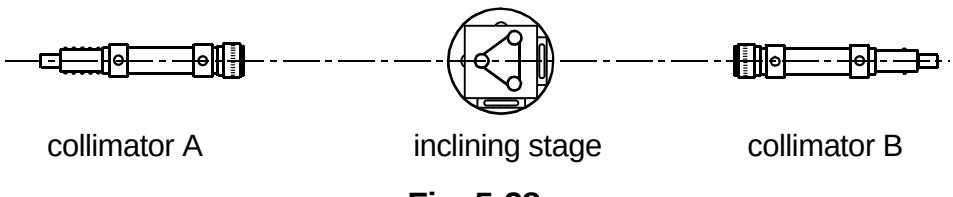



**Fig. 5-28**

**<Adjustment>**

**(6)** Remove the cover and the compensator cover (☞ section 3.12 page 3-21).

**(7)** Loosen the compensator fixing screws (3 pcs).

**(8)** Slightly turn the compensator complete against the optical axis (in one of directions indicated by the arrow mark in Fig. 5-29).

**(9)** Tighten the compensator frame screws with torque of 2.4 ± 0.5 kgf·cm (0.24 ± 0.05 N·m).

**(10)** Recheck the compensator accuracy in the left to right direction and also in the front to back direction (☞ section 5.2.13). Finally apply the locking agent (S91) to the compensator fixing screws.

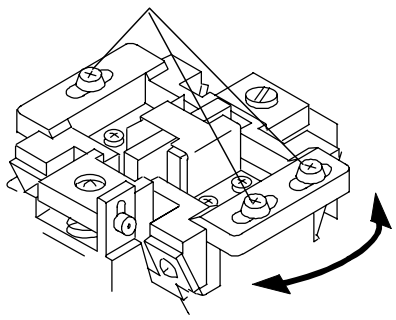



**Fig. 5-29**

# 5.2.15 RANGE OF COMPENSATION (FOR FRONT TO BACK TILT)

**<Inspection>**

**(1)** Place the test level on the telescope frame and precisely level the instrument observing the bubble of the test level vial.

**(2)** Sight the collimator B. If necessary, using the instrument reticle adjusting screw, align the horizontal reticles.

**(3)** Turn the levelling screw [2] in line with the collimator to tilt the instrument in the front to back direction in an elevation angle until the reticle stops going back to the center part (i.e. the compensator stops working). Check the tilt angle (a) of the instrument observing the bubble of the test level vial.

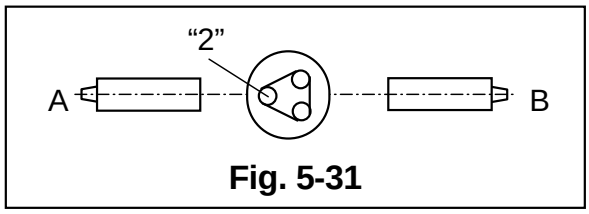



**Fig. 5-31**

**(4)** Check the tilt angle (b) of the instrument for the other direction (in a depression angle) in the same manner as the above step (3).

**(5)** Check that (a) and (b) and the difference between (a) and (b) are within the tolerance.

| | |
|---|---|
| **Range :** | **16' or more** |
| **Difference between upper and lower bounds:** | **4' or more** |

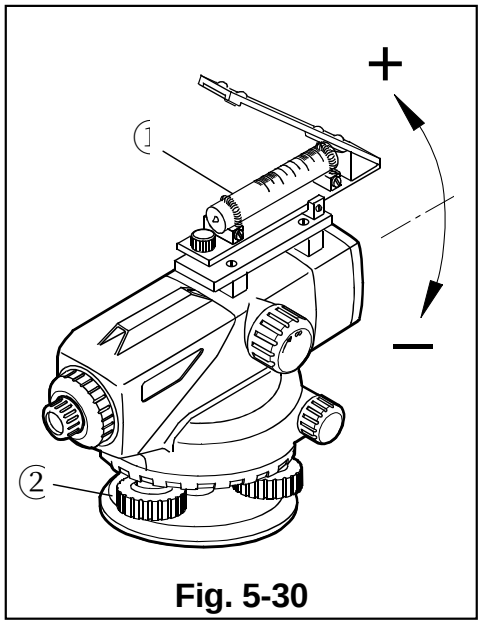



**Fig. 5-30**

✍ If the incling stage is used, tilt the incling stage observing the bubble of the incling stage level vial.

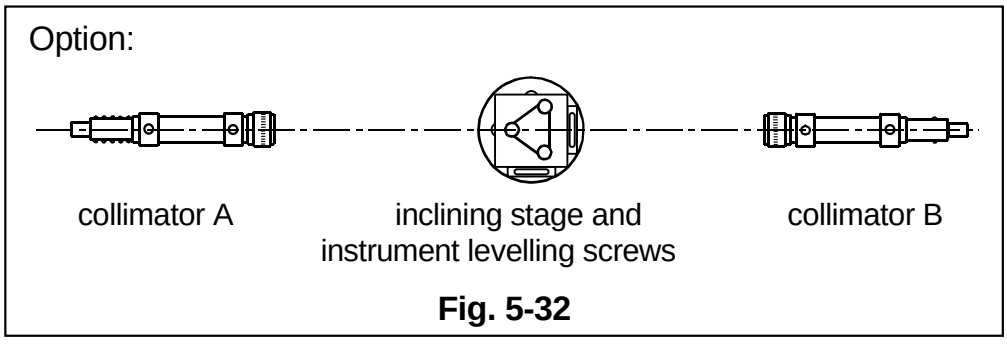



**Fig. 5-32**

**<Adjustment>**

**(6)** Remove the cover and the compensator cover (☞ section 3.12 page 3-21).

**(7)** Adjust the compensator stopper position.

**<Caution>**

Ensure that the pin does not touch the side of the stopper. Keep a gap equally on both sides.

**(8)** Tighten the 2 stopper fixing screws with torque of 1.2 ± 0.3 kgf·cm (0.12 ± 0.03 N·m).

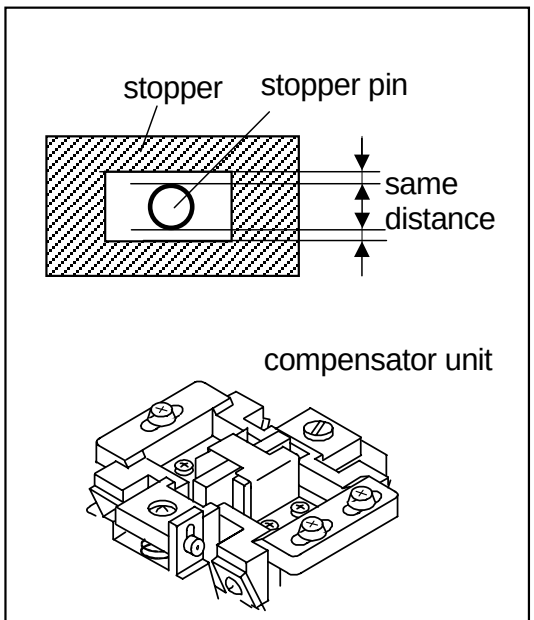



**Fig. 5-33**

## 5.2.16 RANGE OF COMPENSATION (FOR LEFT TO RIGHT TILT)

**<Inspection>**

**(1)** Place the test level on the telescope frame and precisely leve1 the instrument observing the bubble of the test level vial.

**(2)** Sight the collimator B. If necessary, Using the instrument reticle adjusting screw, align the horizontal reticles.

**Range : 16' or more**
**Difference between upper and lower bounds: 4' or more**

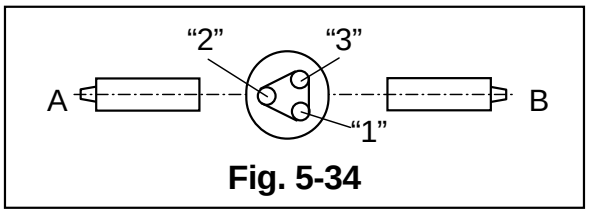



**Fig. 5-34**

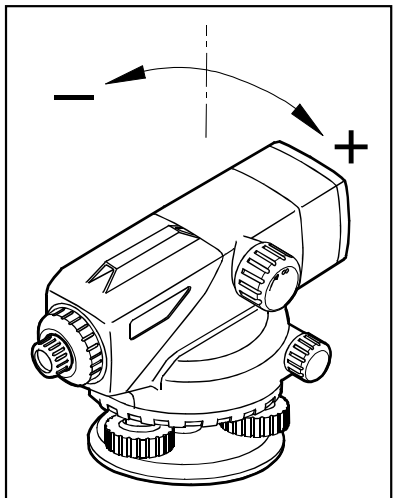



**Fig. 5-35**

**(3)** Turn the telescope frame 90° and rotate the 2 levelling screws "1" and "3" (☞ Fig. 5-34) by the same amount in the opposite rotation directions to tilt the instrument +16' in the left to right direction observing the bubble of the test level vial. Then resight the collimator B (if necessary turn the levelling screw "2" to relevel the instrument in the front to back direction and recheck the left to right direction).

**(4)** While sighting the collimator B, check that the compensator is working (i.e. the instrument horizontal reticle is going back to the collimator horizontal reticle).

**(5)** Tilt the instrument -16' in the left to right direction in the same manner as the above steps (3). Resight the collimator B. Check that the compensator is working (i.e. the instrument horizontal reticle is going back to the collimator horizontal reticle).

✍ To tilt the instrument in more simple way, the levelling base can be turned 90° on the instrument support stand in advance. While the 2 levelling screws (i.e. the line passing through the center of the levelling screws) are set parallel to the optical axes of the collimators, the levelling screw "1" (☞ Fig. 5-36) can be used to incline the instrument in the left to right direction.

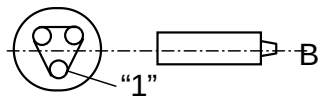
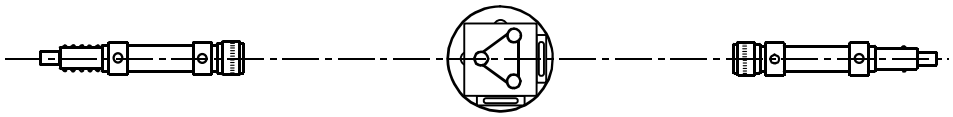



**Fig. 5-36**

✍ If the inclining stage (ST-RA-03) is used, tilt the stage with the instrument in the direction perpendicular to the optical axes of the collimators ("+" direction) until the reticle stops going back to the center part (i.e. the compensator stops working) as observed against the collimator B horizontal reticle. Confirm the tilt angle (a) by checking the bubble position of the inclining stage level vial.
Next tilt the inclining stage with the instrument in the direction perpendicular to the optical axes of the collimators (" – " direction) until the reticle stops going back to the center part as observed against the collimator B horizontal reticle. Confirm the tilt angle (b) by checking the bubble position of the inclining stage level vial. Check that (a) and (b) and the difference between (a) and (b) are within the tolerance.

Option:



collimator A  inclining stage  collimator B

**Fig. 5-37**

**<If out of the tolerance>**

If the range of compensation is out of the tolerance, adjust the compensator stopper position. Ensure that the pin does not touch the side of the stopper. Keep a gap equally on both sides.

Iif necessary also confirm setting of the compensator stop screws as described in section 3.12 page 3-21). Recheck the range of compensation in the front to back direction (☞ section 5.2.15). Tighten the 2 stopper fixing screws with torque of 1.2 ± 0.3 kgf·cm (0.12 ± 0.03 N·m) and apply the locking agent (S91) to the screws.

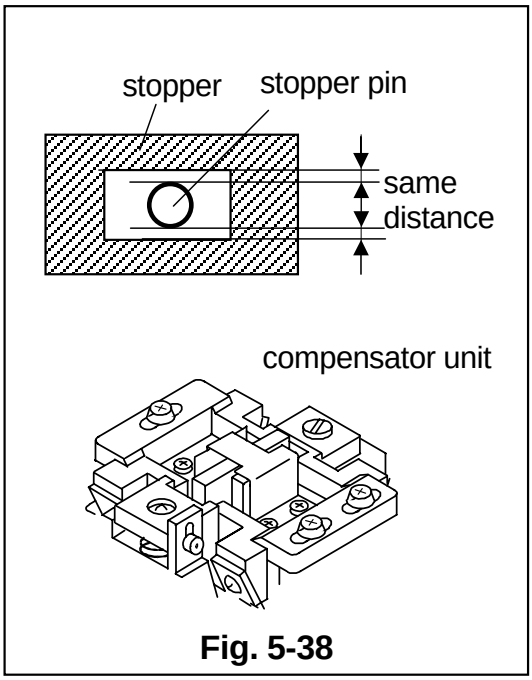



**Fig. 5-38**

**(6)** Relocate the compensator cover with sealing. Tighten the compensator cover fixing screws (4 pcs) with torque of 1.5 ± 0.1 kgf·cm (0.15 ± 0.01 N·m). Apply the locking agent (S91) to the compensator cover fixing screws.

**<Caution>**

To preserve the instrument water resistance change the cover sealing (☞ section 6.5 page 6-7, illustration No. 5-10) every time when the compensator cover with sealing is removed and attached to the telescope frame.

**(7)** Relocate the cover and apply the locking agent (S91) to the cover fixing screws (2 pcs).

# 5.2.17 ECCENTRICITY OF HORIZONTAL CIRCLE

**Tolerance:**
**15' or less**

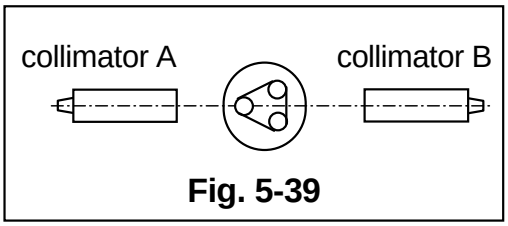



**Fig. 5-39**

**(1)** Level the instrument and sight one of the collimators (collimator A).

**(2)** Turn the horizontal circle positioning ring to align the horizontal circle 0° graduation with the indicator.

**(3)** Turn the the instrument telescope through 180° and precisely sight the other collimator (collimator B).

**(4)** Find the error $d_1$ from 180° reading of the scale.

**(5)** Sight the collimator A and turn the horizontal circle positioning ring to align the horizontal circle 180° graduation with the indicator.

**(6)** Turn the instrument telescope through 180° and precisely sight the collimator B.

**(7)** Find the error $d_2$ from 0° reading of the scale.

**(8)** Calculate the horizontal circle eccentricity error as $(d_1 - d_2)/2$.

**(9)** Turn the instrument telescope through 90° and then turn the whole unit incuding the base plate to sight the collimator A.

**(10)** Repeat procedures of steps (1)~(8) for 90° and 270° directions. Calculate the horizontal circle eccentricity error.

**(11)** Use the bigger value of the 2 settings at 0° and 90° (i.e. eccentricity errors calculated in steps (8) and (10) as the examination data.

**< If out of the tolerance >**

Check the parts of the levelling assembly and the vertical axis (☞ section 3.1).

# 5.2.18 HORIZONTAL ACCURACY

**Tolerance:**
**5” or less**

**(1)** Place the instrument on the collimator support stand. Bring the unit to the collimator height and tighten the fixing clamp. Level the instrument.

**(2)** Sight the collimator A or B and if necessary, adjust the reticle adjusting screw [1] to align the instrument and collimator horizontal reticles.

**(3)** Apply G31 to the reticle cover sealing and attach the reticle cover to the instrument.

**(4)** Turn the instrument 360° clockwise and then counterclockwise and resight the collimator. Confirm that the horizontal reticles are aligned within 5”.

**(5)** Repeat step (4) total 6 times. Confirm that the instrument horizontal reticle remains aligned with the collimator reticle within the tolerance.

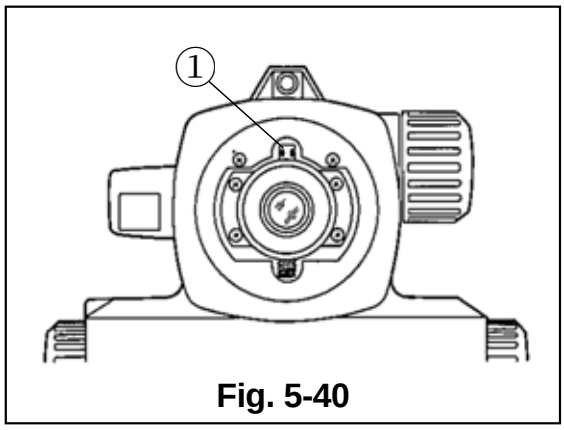



**Fig. 5-40**

**< If out of the tolerance >**

Confirm the compensator adjustment (☞ section 5.2.13~5.2.16) and the conditions of the optical and mechanical units of the compensator (dust, dirt, sticky parts).

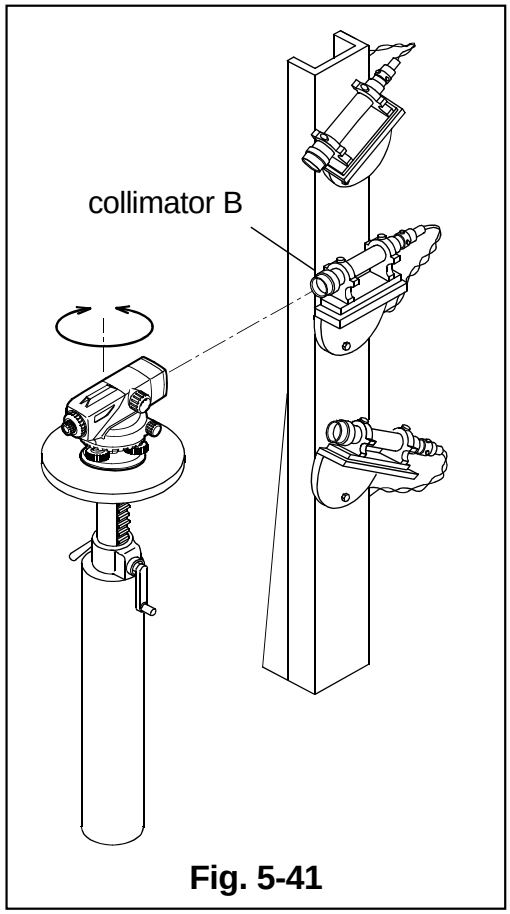



**Fig. 5-41**

# 5.2.19 FINDER

(AT-B2/B3)

**<Inspection>**

**(1)** Sight a target with the finder at a distance of more than l0m.

**(2)** Look through the eyepiece and check the difference from the target. Check if the sighting error is within the tolerance.

**Tolerance:**
**Right/Left: 10' or less**

**<Adjustment>**

**(3)** Adjust the finder set screws [1].

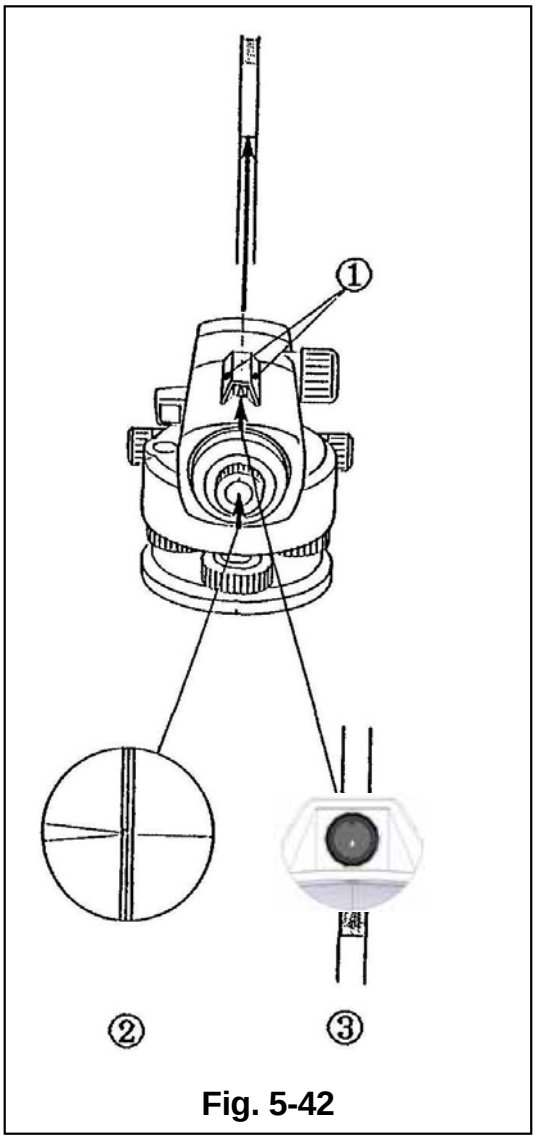



**Fig. 5-42**

# 6. EXPLODED VIEW

## (NAMES OF PARTS, LUBRICATION)

Gxx shown in the exploded view diagrams of this chapter specifies the part code for the grease applied to the particular parts of the instruments, Sxx (or Sxxx) specifies the part code for the adhesives.

# 6.1 LEVELLING BASE, VERTICAL AXIS

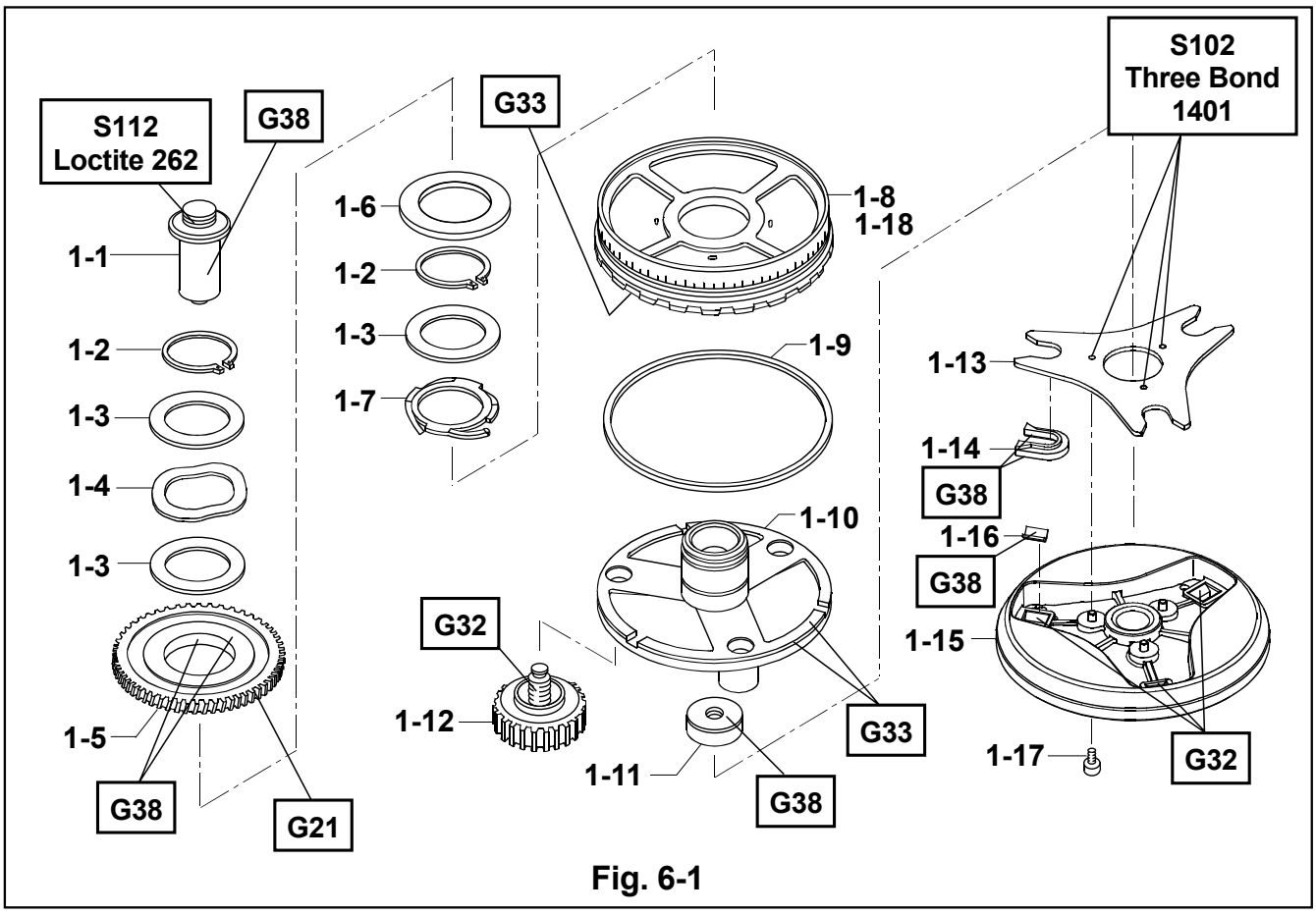



**Fig. 6-1**

| | | | |
|---|---|---|---|
| 1-1 | vertical axis | 1-10 | levelling head |
| 1-2 | C ring | 1-11 | vertical axis nut |
| 1-3 | plate A | 1-12 | levelling screw complete |
| 1-4 | wave washer | 1-13 | levelling screw retainer |
| 1-5 | worm wheel | 1-14 | levelling screw pad |
| 1-6 | washer B | 1-15 | base plate |
| 1-7 | plate spring, worm wheel | 1-16 | levelling screw plate |
| 1-8 | horizontal circle complete (360°) | 1-17 | screw, 3.0x6.0mm |
| 1-9 | ring, horizontal circle | 1-18 | horizontal circle complete (400g) |

# 6.2 FINE MOTION SCREW, CIRCULAR LEVEL, REFLECTOR

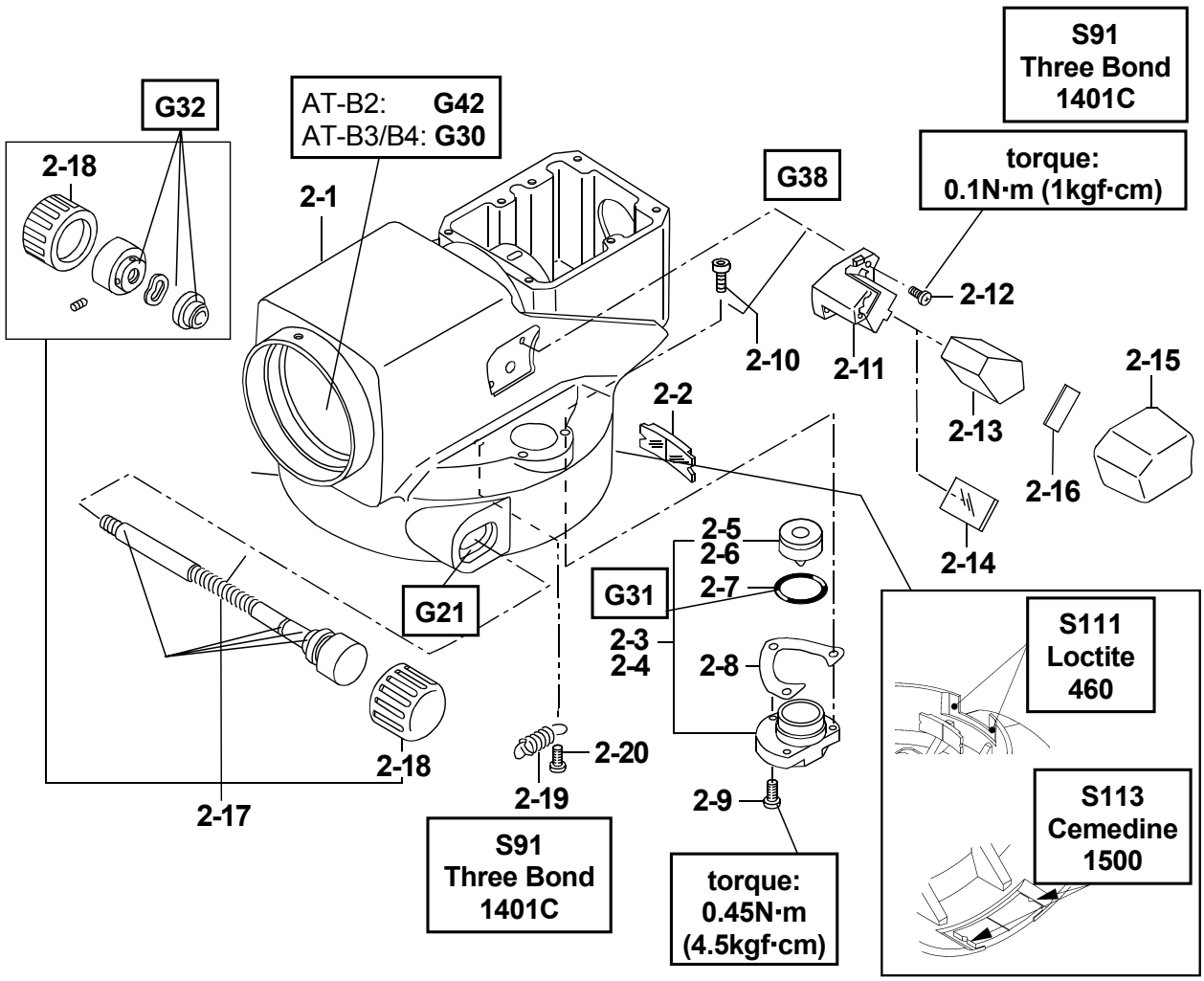



**Fig. 6-2**

| | | | |
|---|---|---|---|
| 2-1 | telescope frame | 2-11 | reflector frame |
| 2-2 | indicator | 2-12 | screw, 2.0x8.0mm |
| 2-3 | circular level complete (AT-B2) | 2-13 | penta-prism (AT-B2) |
| 2-4 | circular level complete (AT-B3/B4) | 2-14 | reflector (AT-B3/B4) |
| 2-5 | circular level vial (AT-B2) | 2-15 | reflector cover |
| 2-6 | circular level vial (AT-B3/B4) | 2-16 | tape, reflector |
| 2-7 | O ring | 2-17 | worm complete |
| 2-8 | circular level spring | 2-18 | fine motion knob cover |
| 2-9 | screw, 2.5x10.0mm | 2-19 | coil spring, worm |
| 2-10 | screw, 2.5x10.0mm | 2-20 | screw, 2.0x4.0mm |

✍ When any parts of the reflector complete are removed and assembled, replace the double-sided adhesive tape (illustration No. 2-16) for a new one.

# 6.3 OBJECTIVE LENS, FOCUSING TUBE, PINION UNIT

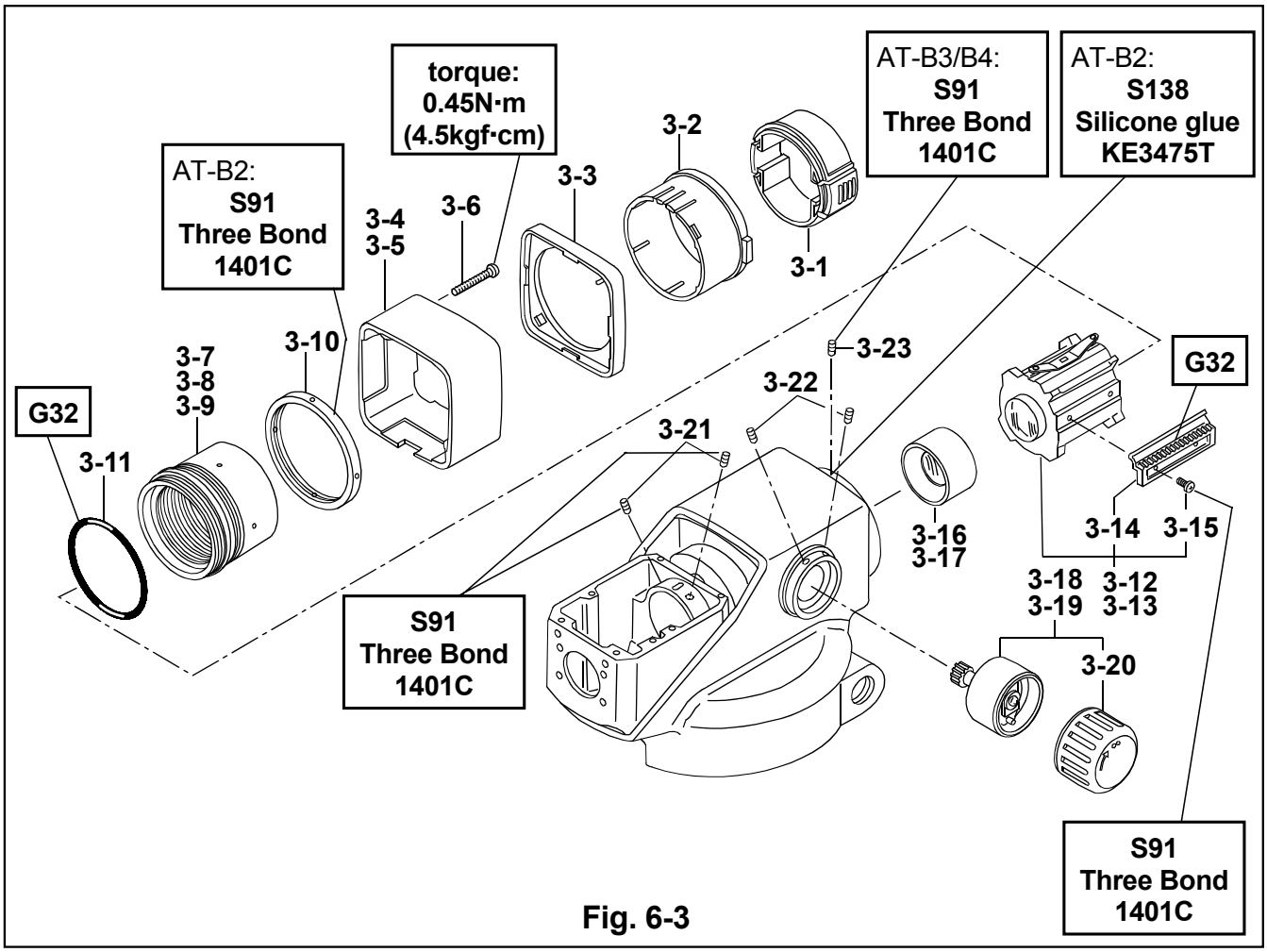



**Fig. 6-3**

| | | | |
|---|---|---|---|
| 3-1 | telescope cap | 3-13 | focusing tube complete (AT-B3/B4) |
| 3-2 | sunshade (AT-B2) | 3-14 | rack |
| 3-3 | objective lens frame cover | 3-15 | screw, 2.0x4.0mm |
| 3-4 | objective lens outer frame (AT-B2) | 3-16 | conversion lens complete (AT-B2) |
| 3-5 | objective lens outer frame (AT-B3/B4) | 3-17 | conversion lens complete (AT-B3/B4) |
| 3-6 | screw, 2.5x30.0mm | 3-18 | pinion complete (AT-B2) |
| 3-7 | objective lens complete (AT-B2) | 3-19 | pinion complete (AT-B3/B4) |
| 3-8 | objective lens complete (AT-B3) | 3-20 | cover, pinion knob |
| 3-9 | objective lens complete (AT-B4) | 3-21 | screw, 2.0x4.0mm |
| 3-10 | stadia adjusting nut (AT-B2) | 3-22 | screw, 2.0x3.0mm |
| 3-11 | O ring | 3-23 | screw, 2.0x3.0mm (AT-B3/B4) |
| 3-12 | focusing tube complete (AT-B2) | | |

# 6.4 COMPENSATOR, RETICLE WITH FRAME

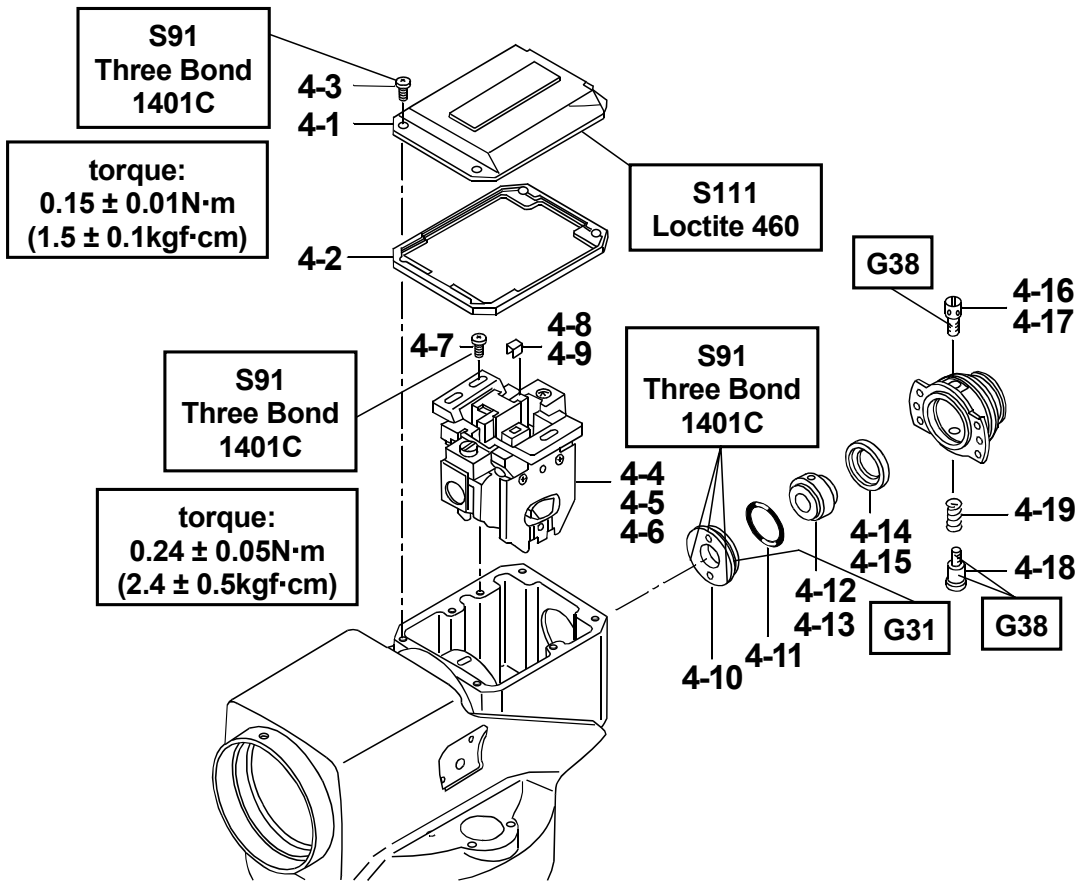



**Fig. 6-4**

4-1 compensator cover
4-2 sealing, compensator cover
4-3 screw, 2.5x8.0mm
4-4 compensator complete (AT-B2)
4-5 compensator complete (AT-B3)
4-6 compensator complete (AT-B4)
4-7 screw, 2.5x8.0mm
4-8 balancer (t=0.3mm)
4-9 balancer (t=0.4mm)
4-10 reticle retainer
4-11 O ring
4-12 reticle w/frame (AT-B2)
4-13 reticle w/frame (AT-B3/B4)
4-14 reticle ring (AT-B2)
4-15 reticle ring (AT-B3/B4)
4-16 adjusting screw, reticle (AT-B2)
4-17 adjusting screw, reticle (AT-B3/B4)
4-18 reticle screw
4-19 reticle spring

✍ To preserve the instrument water resistance change the cover sealing (☞ section 6.5 page 6-7, illustration No. 5-10) every time when the compensator cover with sealing is removed and attached to the telescope frame.

# 6.5 TELESCOPE FRAME COVER

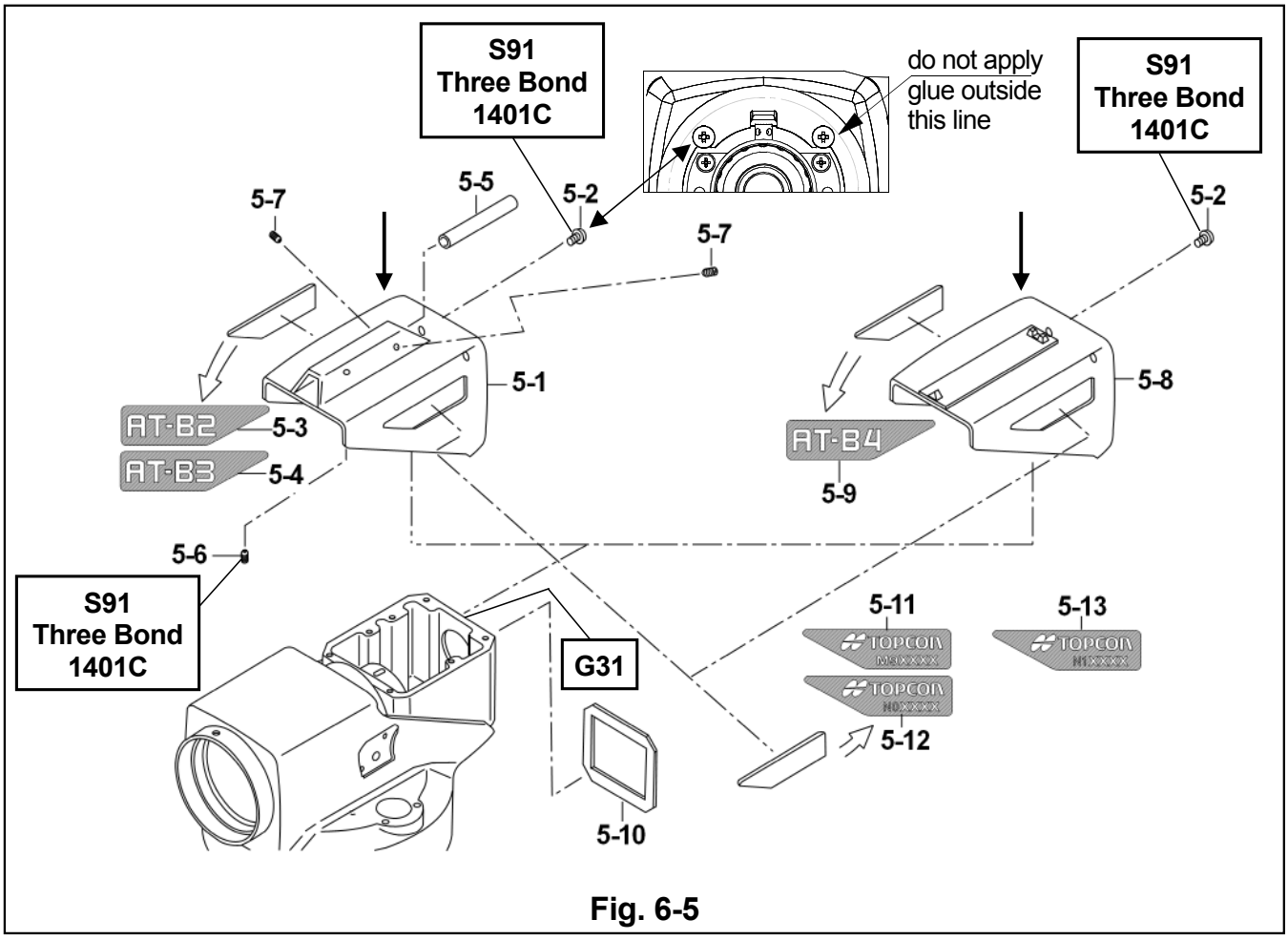



**Fig. 6-5**

| | | | |
|---|---|---|---|
| 5-1 | cover (AT-B2/B3) | 5-6 | screw, 2.0x3.0mm (AT-B2/B3) |
| 5-2 | screw, 2.5x6.0mm | 5-7 | screw, 2.0x3.0mm (AT-B2/B3) |
| 5-3 | AT-B2 name plate | 5-8 | cover (AT-B4) |
| 5-4 | AT-B3 name plate | 5-9 | AT-B4 name plate |
| 5-5 | finder complete (AT-B2/B3) | 5-10 | sealing, cover |

TOPCON labels with serial number for AT-B2/B3/B4 (illustration No. 5-11, 5-12 and 5-13) are not supplied as the spare parts.

While installing the cover push it downward (as shown by arrow marks in Fig. 6-5) and then tighten the 2 fixing screws (illustration No. 5-2).

# 6.6 EYEPIECE

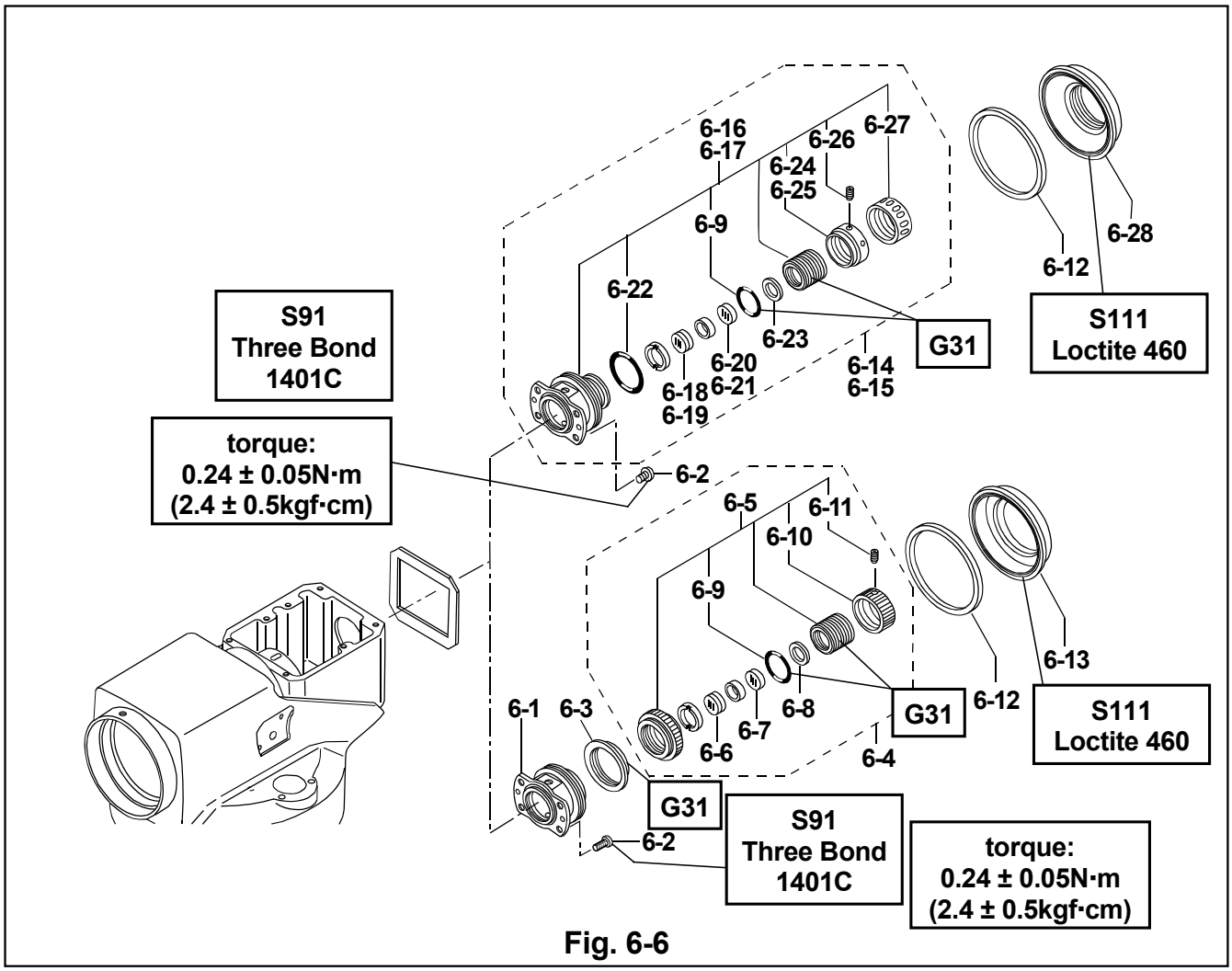



**Fig. 6-6**

| | | | |
|---|---|---|---|
| 6-1 | eyepiece outer frame (AT-B2) | 6-15 | eyepiece complete 24x (AT-B4) |
| 6-2 | screw, 2.5x6.0mm | 6-16 | eyepiece w/o lens 28x (AT-B3) |
| 6-3 | sealing, eyepiece (AT-B2) | 6-17 | eyepiece w/o lens 24x (AT-B4) |
| 6-4 | eyepiece complete (AT-B2) | 6-18 | eyepiece lens D (AT-B3) |
| 6-5 | eyepiece w/o lens (AT-B2) | 6-19 | eyepiece lens D (AT-B4) |
| 6-6 | eyepiece lens D (AT-B2) | 6-20 | eyepiece lens E (AT-B3) |
| 6-7 | eyepiece lens E (AT-B2) | 6-21 | eyepiece lens E (AT-B4) |
| 6-8 | sealing, eyepiece lens (AT-B2) | 6-22 | O ring (AT-B3/B4) |
| 6-9 | O ring | 6-23 | sealing, eyepiece (AT-B3/B4) |
| 6-10 | eyepiece knob (AT-B2) | 6-24 | eyepiece knob (AT-B3) |
| 6-11 | screw, 2.0x2.0mm (AT-B2) | 6-25 | eyepiece knob (AT-B4) |
| 6-12 | sealing, reticle cover | 6-26 | screw, 2.0x2.0mm (AT-B3/B4) |
| 6-13 | reticle cover (AT-B2) | 6-27 | eyepiece knob cover (AT-B3/B4) |
| 6-14 | eyepiece complete 28x (AT-B3) | 6-28 | reticle cover (AT-B3/B4) |

# 6.7 CARRYING CASE, STANDARD EQUIPMENT, ACCESSORIES

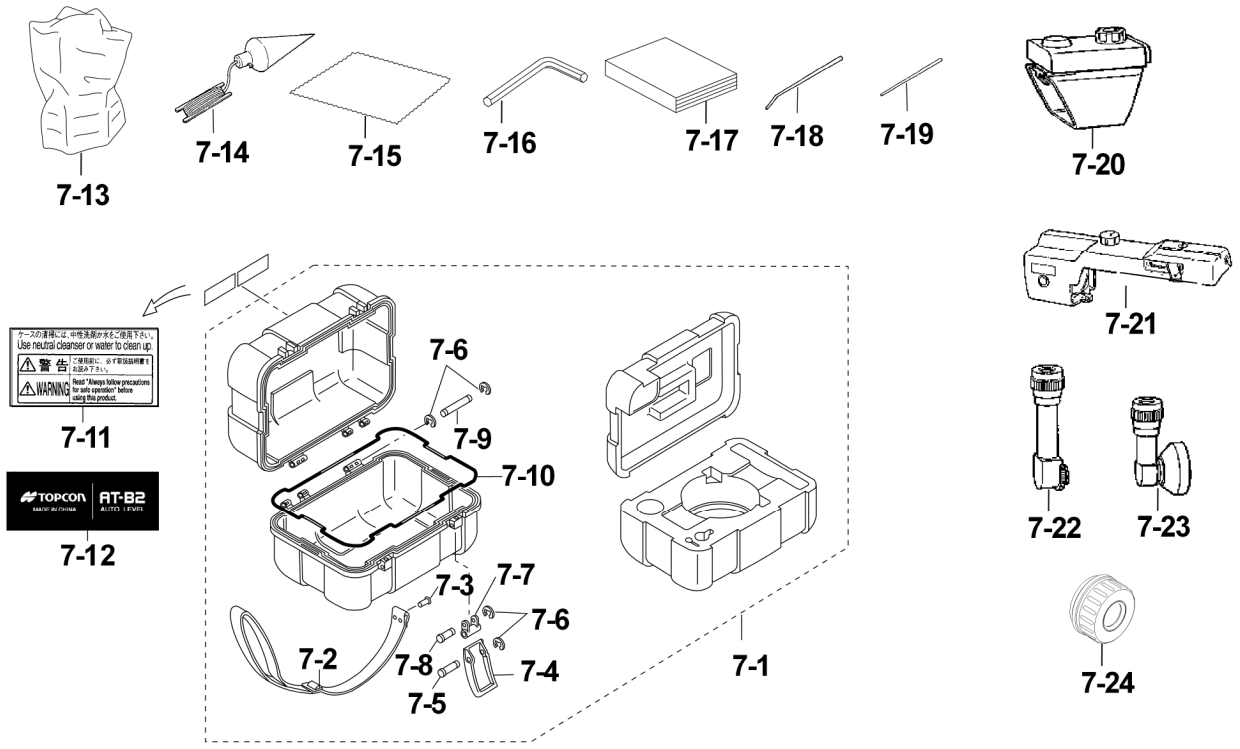



**Fig. 6-7**

| | | | |
|---|---|---|---|
| 7-1 | plastic case complete (SE35A) (AT-B2) | 7-13 | nylon cover |
| 7-2 | strap w/rivet (AT-B2) | 7-14 | plumb bob |
| 7-3 | rivet (AT-B2) | 7-15 | cleaning cloth |
| 7-4 | latch | 7-16 | hexagonal wrench |
| 7-5 | latch pin | 7-17 | operation manual |
| 7-6 | E ring | 7-18 | adjusting pin |
| 7-7 | pivoting bar | 7-19 | adjusting pin, straight (AT-B2) |
| 7-8 | pin, pivoting bar | 7-20 | illumination pack (LA8) |
| 7-9 | hinge pin (AT-B2) | 7-21 | optical micrometer (OM5) |
| 7-10 | sealing (AT-B2) | 7-22 | diagonal eyepiece (DE16) |
| 7-11 | warning label | 7-23 | diagonal eyepiece (DE22) |
| 7-12 | case name plate (AT-B2) | 7-24 | removable eyepiece 40x (EL5) |

7-20~7-22, 7-24 are optional accessories for the AT-B2, 7-23 is the optional accessory for the AT-B3/B4

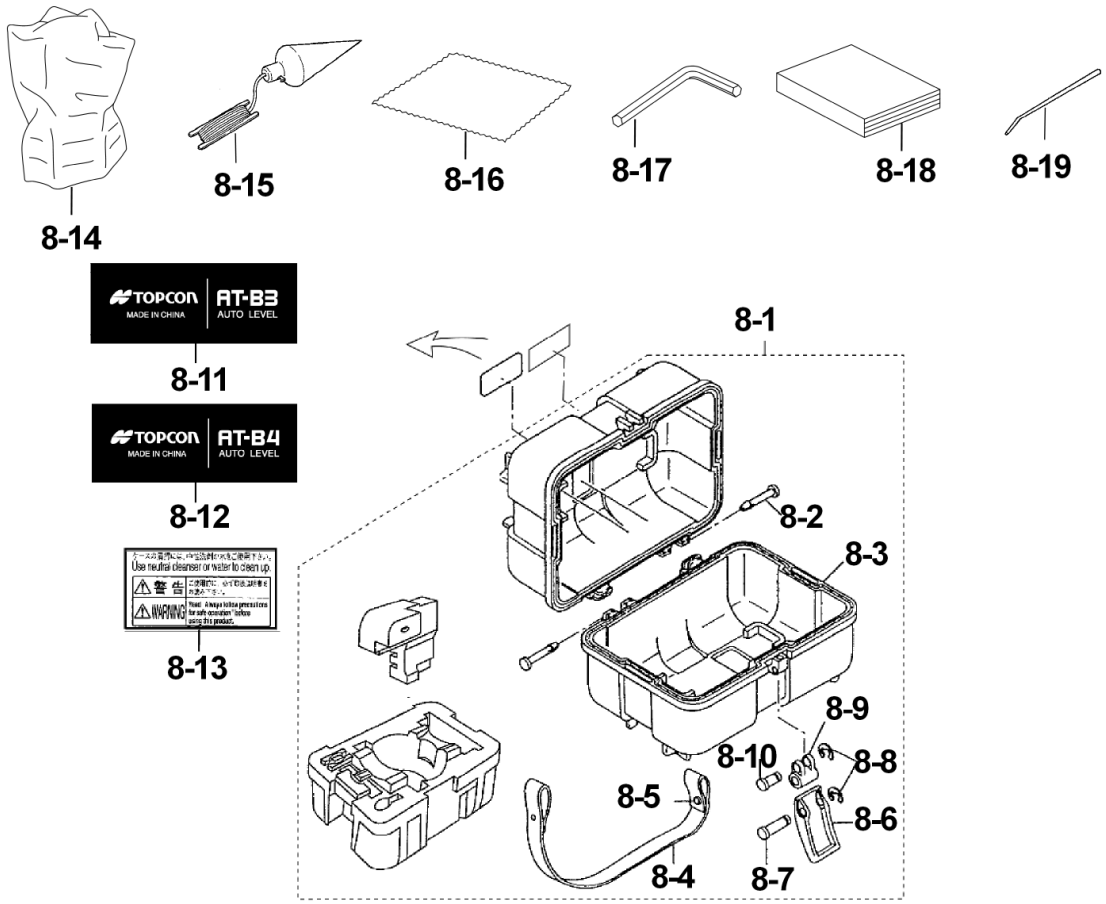



**Fig. 6-8**

| | | | |
|---|---|---|---|
| 8-1 | plastic case complete (SE49A) (AT-B3/B4) | 8-11 | case name plate (AT-B3) |
| 8-2 | pin, hinge pin (AT-B3/B4) | 8-12 | case name plate (AT-B4) |
| 8-3 | sealing (AT-B3/B4) | 8-13 | warning label |
| 8-4 | strap w/rivet (AT-B3/B4) | 8-14 | nylon cover |
| 8-5 | rivet (AT-B3/B4) | 8-15 | plumb bob |
| 8-6 | latch | 8-16 | cleaning cloth |
| 8-7 | latch pin | 8-17 | hexagonal wrench |
| 8-8 | E ring | 8-18 | operation manual |
| 8-9 | pivoting bar | 8-19 | adjusting pin |
| 8-10 | pin, pivoting bar | | |

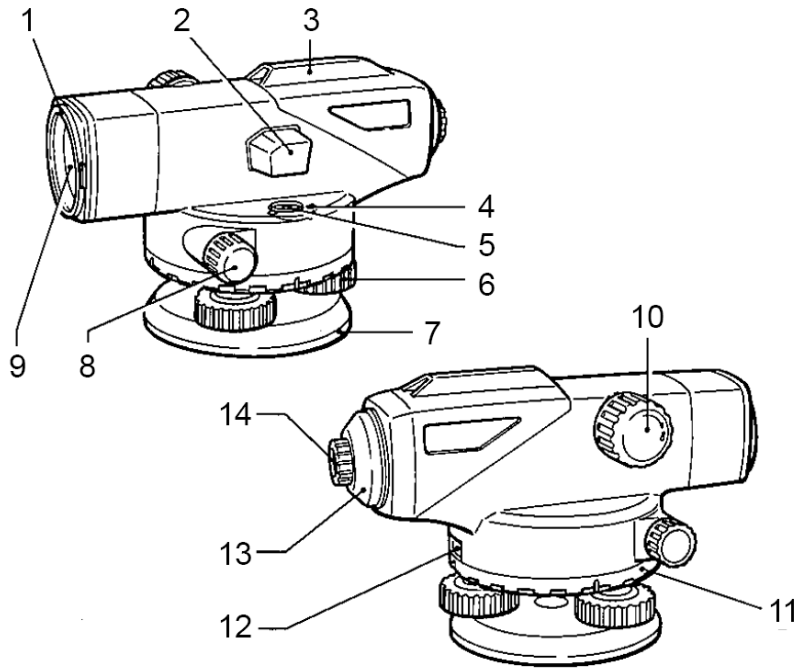
# 7. APPENDICES

# I. SPECIFICATIONS

| | | AT-B2 | AT-B3 | AT-B4 |
|---|---|---|---|---|
| **Telescope** | | | | |
| Length | | 215mm (8.46 in.) | | |
| Image | | (1.26 in.) | | |
| Objective aperture | | 42mm (1.65 in.) | 36mm (1.42 in.) | 32mm (1.26 in.) |
| Magnification | | 32x | 28x | 24x |
| Field of view (at 100m/328ft.) | | 1°20' (2.3m/7.5ft.) | 1°25' (2.5m/8.2ft.) | |
| Resolving power | | 3.0" | 3.5" | 4.0" |
| Minimum focus | | 0.3m (1ft.) | | |
| Stadia ratio | | 1:100 | | |
| Additive constant | | 0 | | |
| **Horizontal circle** | | | | |
| Diameter | | 103mm (4.1in.) | | |
| Graduation | | 1°/1gon | | |
| **Automatic compensator** | | | | |
| Range | | ±15' | | |
| **Circular level** | | | | |
| Sensitivity | | 10'/2mm | | |
| **Standard deviation for 1 km of double run leveling** | | | | |
| | | 0.7mm (0.03in.) | 1.5mm (0.06in.) | 2.0mm (0.08in.) |
| With micrometer | | 0.5mm (0.02in.) | -------- | |
| **Water resistance** | | IPx6 (IEC60529:2001) | | |
| **Operating temperature range** | | -20 to 50°C (-4 to 122°F) | | |
| **Storage temperature range** | | -40 to 70°C (-40 to 158°F) | | |
| **Size** | Width | 130mm (5.12in.) | | |
| | Length | 215mm (8.46in.) | | |
| | Height | 140mm (5.51in.) | | 135mm (5.31in.) |
| **Weight** | | 1.85kg (4.1lbs) | 1.7kg (3.7lbs) | |

# II. NAMES OF PARTS

(Instrument shown: AT-B2)

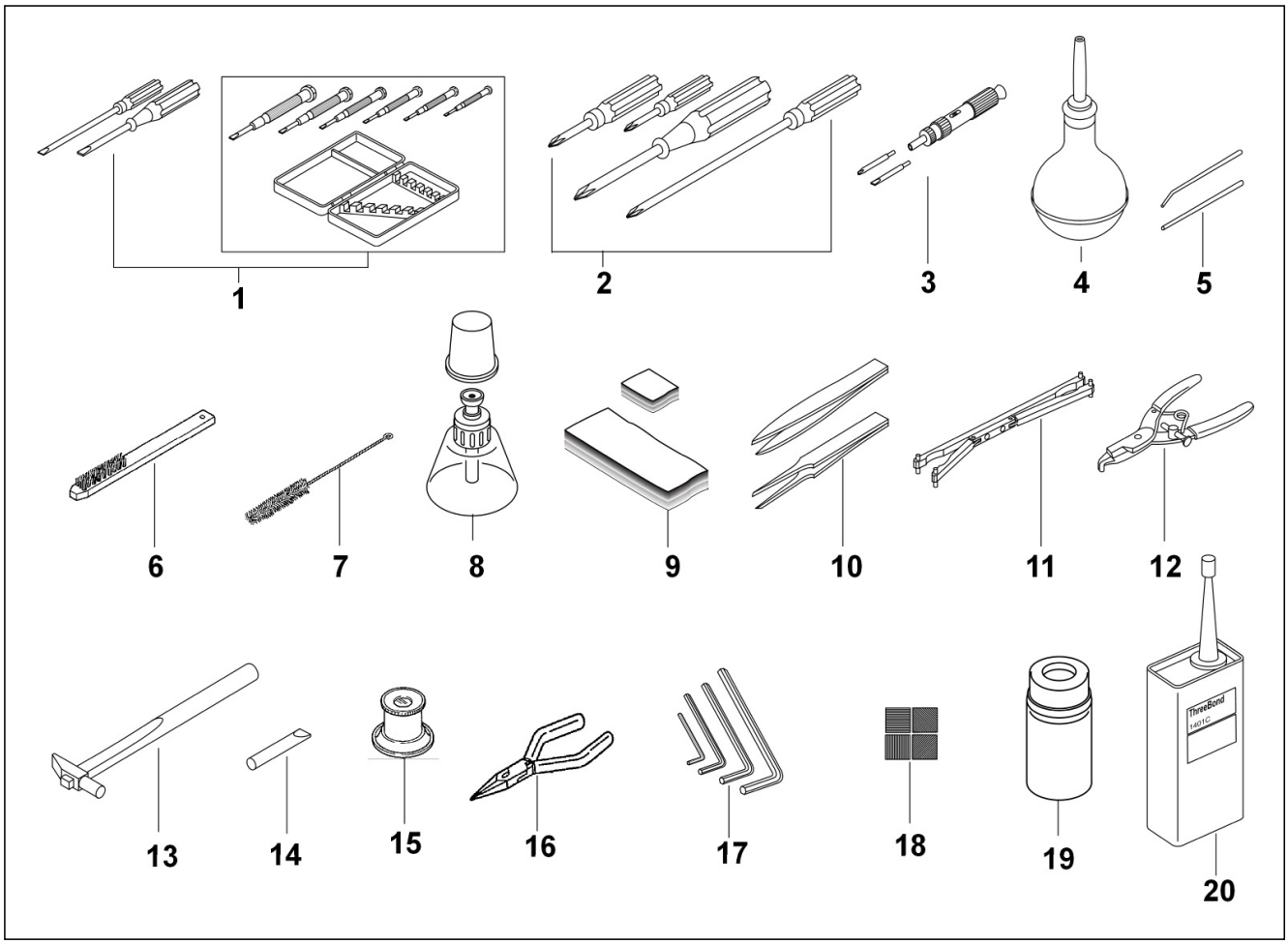



| | | | |
|---|---|---|---|
| 1 | Lens hood (AT-B2 only) | 8 | Horizontal fine motion screw |
| 2 | Prism (AT-B2)/Reflector (AT-B3/B4) | 9 | Objective lens |
| 3 | Peep sight[*1] | 10 | Focusing knob |
| 4. | Circular level adjusting screw | 11 | Horizontal circle positioning ring |
| 5. | Circular level | 12 | Horizontal circle window |
| 6 | Leveling foot screw | 13 | Reticle adjusting screw cover |
| 7 | Base plate | 14 | Eyepiece[*2] |

[*1] The AT-B4 has a gun sight
[*2] The AT-B2 eyepiece is detachable

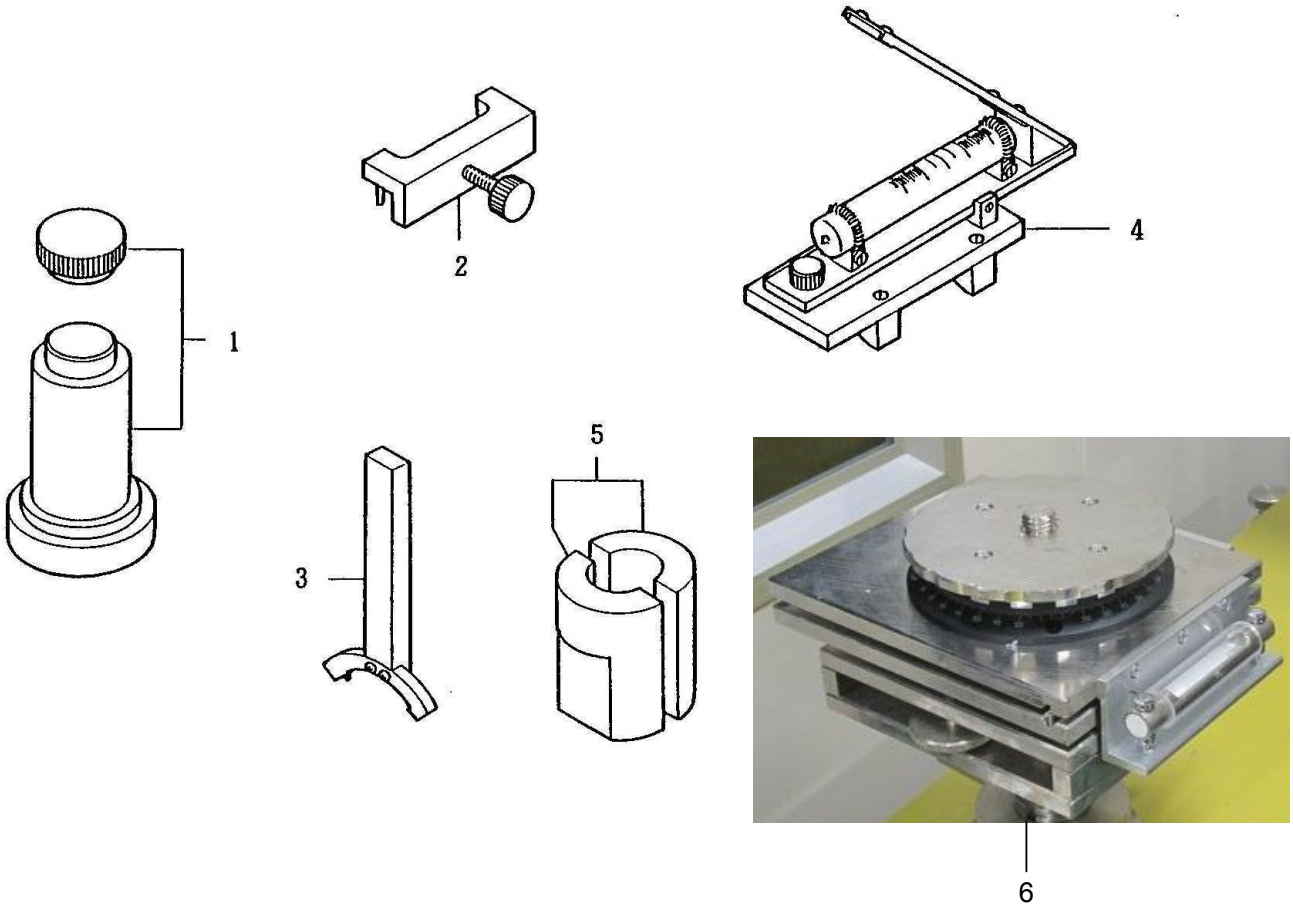
# III. TOOLS

## III.1 GENERAL TOOLS




1. Screwdrivers
2. Screwdrivers
3. Torque driver
4. Dust blower
5. Adjusting pin
6. Brush
7. Hole brush
8. Alcohol fountain
9. Lens tissue
10. Tweezers
11. Spanner
12. Snap ring pliers
13. Mascot hammer
14. Plastic bar
15. Dynameter
16. Pliers
17. Hexagonal wrench (0.89mm, 1.5mm, 2mm, 2.5mm)
18. Inspection chart (S94)
19. Grease (G21, G30, G31, G32, G33, G38, G42)
20. Adhesive: Three Bond 1401C (S91),
    Three Bond 1401 (S102), Loctite 262 (S112),
    silicone KE3475T (S138), Cemedine 1500 (S113),
    Loctite 460 (S111), shellac (lac) (S35)

# III.2 SPECIAL TOOLS




l. Conversion lens mounting tool (S055-004)
2. Compensator mounting too1 ( S055-002)
3. Stadia nut mounting tool (S055-003)
4. Test level (S055-001)
5. Vertical axis mounting tool (S055-006)
6. Inclining stage (ST-RA-03) (Note: it can be used optionally with the test level (4) to tilt the instrument for the inspection of the automatic compensation accuracy and range)

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